ForeRunner ASN-9000 Hardware Reference Manual

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Legal Notices

FCC CLASS A NOTICE

WARNING: Changes or modifications to this unit not expressly approved by the party responsible for compliance could void this user's authority to operate this equipment.

NOTE: The *ForeRunner* ASN-9000 has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15, FCC Rules. These limits are designed to provide reasonable protection against harmfull interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

DOC CLASS A NOTICE

This digital apparatus does not exceed Class A limits for radio noise emission for a digital device as set out in the Radio Interference Regulations of the Canadian Department of Communications.

Le present appareil numerique n'emet pas de bruits radioelectriques depassant les limites applicables aux appareils numeriques de la class A prescrites dans le reglement sur le brouillage radioelectrique edicte par le ministere des Communications du Canada.

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従って、住宅地域またはその隣接した地域で使用すると、ラジオ、テレビジョン受信機等に受信障害を与えることがあります。

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This equipment is in the Class 1 category (Information Technology Equipment to be used in commercial and/or industrial areas) and conforms to the standards set by the Voluntary Control Council For Interference by Information Technology Equipment aimed at preventing radio interference in commercial and/or industrial areas.Consequently, when used in a residential area or in an adjacent area thereto, radio interference may be caused to radios and TV receivers, etc. Read the instructions for correct handling.

CE NOTICE

Marking by the symbol **CE** indicates compliance of this system to the EMC (Electromagnetic Compatibility) directive of the European Community and compliance to the Low Voltage (Safety) Directive. Such marking is indicative that this system meets or exceeds the following technical standards:

- EN 55022 - "Limits and Methods of Measurement of Radio Interference Characteristics of Information Technology Equipment."
- EN 50082-1 - "Electromagnetic compatibility - Generic immunity standard Part 1: Residential, commercial, and light industry."

SAFETY CERTIFICATIONS

ETL certified to meet Information Technology Equipment safety standards UL 1950 3rd Edition, CSA22.2, No. 950-95, EN 60950 (1992) and IEC 950, 2nd Edition.

CANADIAN IC CS-03 COMPLIANCE STATEMENT

NOTICE: The Industry Canada label identifies certified equipment. This certification means that the equipment meets certain telecommunications network protective, operational and safety requirements. The Industry Canada label does not guarantee the equipment will operate to the user's satisfaction.

Before installing this equipment, users should ensure that it is permissible to be connected to the facilities of the local telecommunications company. The equipment must also be installed using an acceptable method of connection. In some cases, the company's inside wiring associated with a single line individual service may be extended by means of a certified connector assembly (telephone extension cord). The customer should be aware that compliance with the above conditions may not prevent degradation of service in some situations.

Repairs to certified equipment should be made by an authorized Canadian maintenance facility designated by the supplier. Any repairs or alterations made by the user to this equipment, or equipment malfunctions, may give the telecommunications company cause to request the user to disconnect the equipment.

Users should ensure for their own protection that the electrical ground connections of the power utility, telephone lines and internal metallic water pipe system, if present, are connected together. This precaution may be particularly important in rural areas.

Caution: Users should not attempt to make such connections themselves, but should contact the appropriate electric inspection authority, or electrician, as appropriate.

TRADEMARKS

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Preface

The intent of this manual is to supply users of the *ForeRunner* ATM Services Node 9000 (ASN-9000) with all the necessary information to install and maintain the ASN-9000 successfully. If questions or problems with the installation arise, please contact FORE Systems' Technical Support.

Chapter Summaries

Chapter 1 - Overview - Provides an overview of the ASN-9000 Local Area Network (LAN) switch. The ASN-9000 chassis is introduced with specific terms and nomenclature explained. Intelligent packet switching, as used in the ASN-9000, is explained. Various configuration options are described. Additionally, some of the software features of the ASN-9000 are described.

Chapter 2 - Chassis and Packet Engine - The major components of the ASN-9000 chassis are described. A description of how the Packet Engine processes traffic through the ASN-9000 is explained. The tasks associated with the Packet Channel Backplane and Power Modules are outlined.

Chapter 3 - ATM Interfaces - The ASN-9000 PowerCell Network Interface Module (NIM) and Asynchronous Transfer Mode (ATM) Media Adapter (AMA) interfaces available for the ASN-9000 are discussed. The various types of AMAs are described and explained in detail.

Chapter 4 - Safety and Environment Requirements - Precautions and environmental concerns when handling ASN-9000 components are explained. The hazards and problems that can occur are discussed.

Chapter 5 - Quickstart - Provides basic quickstart information to assist in getting the *ForeRunner* ASN-9000 platform installed and operating.

Chapter 6 - Removal and Installation Procedures - This chapter provides procedures to remove and install ASN-9000 components. The procedures include the removal and installation of components while the ASN-9000 is operating.

Chapter 7 - Boot PROM Commands - The ASN-9000 supports a series of boot PROM commands. These commands are available to the user in the event the ASN-9000 fails initial loading. The section describes these commands, with the necessary syntax of each being described.

Appendix A- Balancing Bandwidth - This appendix discusses how to configure load-balancing in both non-blocking and blocking configurations to improve the packet-forwarding capacity of the ASN-9000 system.

Acronyms - Common networking acronyms and their meanings are provided.

Glossary - Descriptions of acronyms and terms used in the networking community and throughout this manual.

Technical Support

In the U.S.A. FORE Systems' Technical Support can be contacted by any one of the following four methods:

1. If Internet access is available, contact FORE Systems' Technical Support via eMail at the following address:

   `support@fore.com`

2. FAX questions/concerns to "support" at:

   412-742-7900

3. Mail questions/concerns via U.S. Mail, to at the following address:

   FORE Systems, Inc.
   1000 FORE Drive
   Warrendale, PA 15086-7502

4. Telephone questions/concerns to "support" at:

   1-800-671-FORE (3673)
   or
   412-635-3700

International customers can contact FORE Systems' Technical Support at:

+1-412-742-6999

Typographical Styles

Throughout this manual, specific commands to be entered by the user appear on a separate line in bold typeface. In addition, use of the Enter or Return key is represented as <ENTER>. The following example demonstrates this convention:

cd /usr <ENTER>

Commands or file names that appear within the text of this manual are represented in the following style: "...the fore_install program installs this distribution"

Important Information Indicators

To call your attention to safety and otherwise important information that must be reviewed to insure correct and complete installation, as well as to avoid damage your system, FORE Systems utilizes the following *WARNING/CAUTION/NOTE* indicators.

WARNING statements contain information that is critical to the safety of the operator and/or the system. Do not proceed beyond a WARNING statement until the indicated conditions are fully understood or met. This information could prevent serious damage to the operator, the system, or currently loaded software, and will be indicated as:

WARNING!

Hazardous voltages are present. To lessen the risk of electrical shock and danger to personal health, follow the instructions carefully.

Information contained in CAUTION statements is important for proper installation/operation. CAUTION statements can prevent possible equipment damage and/or loss of data and will be indicated as:

CAUTION

You risk damaging your equipment and/or software if you do not follow these instructions.

Information contained in NOTE statements has been found important enough to be called to the special attention of the operator and will be set off from the text as follows:

NOTE

Steps 1, 3, and 5 are similar to the installation for the computer type above. Review the previous installation procedure before installation in your particular model.

Laser Warning

Class 1 Laser Product:
This product conforms to applicable requirements of 21 CFR 1040 at the date of manufacture.

Class 1 lasers are defined as products which do not permit human access to laser radiation in excess of the accessible limits for Class 1 for applicable wavelengths and durations. These lasers are safe under reasonably foreseeable conditions of operation.

The ASN-9000 ATM single-mode physical layer ATM Media Modules (AMAs) contain Class 1 lasers.

Safety Agency Compliance

This preface provides safety precautions to follow when installing a FORE Systems, Inc., product.

Safety Precautions

For your protection, observe the following safety precautions when setting up your equipment:

- Follow all warnings and instructions marked on the equipment.
- Ensure that the voltage and frequency of your power source matches the voltage and frequency inscribed on the equipment's electrical rating label.
- Never push objects of any kind through openings in the equipment. Dangerous voltages may be present. Conductive foreign objects could produce a short circuit that could cause fire, electric shock, or damage to your equipment.

Symbols

The following symbols appear in this book.

WARNING!

Hazardous voltages are present. If the instructions are not heeded, there is a risk of electrical shock and danger to personal health.

CAUTION

If instructions are not followed, there is a risk of damage to the equipment.

Modifications to Equipment

Do not make mechanical or electrical modifications to the equipment. FORE Systems, Inc., is not responsible for regulatory compliance of a modified FORE product.

Placement of a FORE Systems Product

CAUTION

To ensure reliable operation of your FORE Systems product and to protect it from overheating, openings in the equipment must not be blocked or covered. A FORE Systems product should never be placed near a radiator or heat register.

Power Cord Connection

WARNING!

FORE Systems products are designed to work with single-phase power systems having a grounded neutral conductor. To reduce the risk of electrical shock, do not plug FORE Systems products into any other type of power system. Contact your facilities manager or a qualified electrician if you are not sure what type of power is supplied to your building.

WARNING!

Your FORE Systems product is shipped with a grounding type (3-wire) power cord. To reduce the risk of electric shock, always plug the cord into a grounded power outlet.

Command Syntax

The following expressions are used in this manual when describing command syntax:

AaBbCcDd A term that is being defined. Example:

IP Helper is an enhancement to the **ip** subsystem that allows an ASN-9000 system to be boot from a server separated from the boot client by a gateway.

AaBbCcDd A command name. ASN-9000 commands are case-sensitive; they should always be issued in lowercase. Example:

```
dir
```

| 1) Separates the full and terse forms of a command or argument:

- The full form is shown on the left of the **|**.
- The terse form is shown on the right of the **|**.

Example:

```
dir | ls
```

When the command or argument is entered, either the full form or terse form may be used. In this example, either **dir** or **ls** can be used.

2) Separates mutually exclusive command arguments. Example:

```
active-ama|aa cset p[rimary]|b[ackup] <slot>|all
```

In this example, the command **active-ama|aa** can accept either **active-ama** or **aa**, but not both.

[ ] Enclose optional command arguments or options. Example:

```
active-ama|aa [show] [linemode|lm] <slot>|all
```

In this example, the **[ ]** enclose optional arguments. The command can be issued without the argument(s) shown in **[ ]**. However, the argument must be one of the two options listed between the **[ ]**.

<*AaBbCcDd*> Indicates a parameter for which a value is supplied by the operator. When used in command syntax, <*italics*> indicates the value to be supplied. Example:

`savecfg <`*`filename`*`>`

In this example, <*filename*> is a parameter for which a value must be supplied with the command when issued.

AaBbCcDd Indicates a field or file name.

An example of a field name is when booting the ASN-9000 software, the `login:` prompt is displayed.

A file name example is when booting the ASN-9000 software, the system looks for a file name `cfg`.

`AaBbCcDd`
`or`
`AaBbCcDd`

Indicates text displayed by the ASN-9000 software or input typed at the command prompt. To distinguish typed input from command output, the typed input is shown in bold typeface. Example:

```
22:ASN-9000:system# bootinfo
Thu Aug 7 13:03:38 1997 start
Thu Aug 7 13:03:43 1997 nvram boot order: m
boot device: m
```

In this example, the user enters **`bootinfo`** and the software responds with

`Thu Aug 7 13:03:38 1997 start`

`Thu Aug 7 13:03:43 1997 nvram boot order: m`

`boot device: m`.

CHAPTER 1 Overview

This chapter provides an overview of the physical characteristics of the *ForeRunner* ATM Services Node 9000 (ASN-9000), including the use of the terms “slot,” “port,” and “segment” as they apply to the ASN-9000. The configuration and management features supported by the ASN-9000 are also introduced. Figure 1.1 shows a fully populated ASN-9000. This chapter provides information on the following subjects:

- ASN-9000 Chassis
- Intelligent Packet Switching
- Chassis Configuration
- Software Features

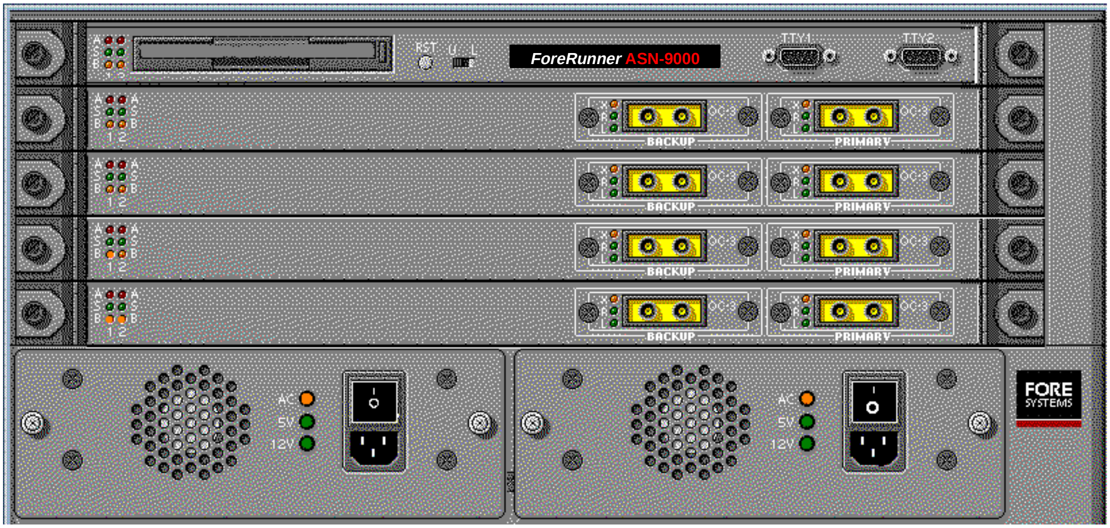

Figure 1.1 - *ForeRunner* ASN-9000

1.1 ASN-9000 Chassis

The ASN-9000 comprises a 5-slot chassis which can be configured with up to two power modules and four ATM Network Interface Modules (NIMs) with up to two ATM Media Adapters (AMAs) per NIM. The heart of the ASN-9000 is the Packet Engine (PE) which supports a two packet-channel backplane. The packet-channel backplane supports 800Mb/s bandwidth per channel throughput providing an aggregate chassis throughput of up to 1.6 Gbp/s. For detailed information on the Packet-Channel Backplane, refer to Section 1.2.1. For detailed information on the PE, refer to Section 1.2.2.

The card slots in the ASN-9000 chassis connect the NIMs with the PE through the Packet Channel Backplane. Security features are available in both the software and on the PE to help to protect the system from unwanted access and tampering. The following sections provide more information on:

- Ports, slots, and segments
- Security

1.1.1 Ports, Slots, and Segments

Ports on the ASN-9000 refer to the two TTY (TTY1/TTY2) ports located on the PE. These ports are used for connecting a console to the system for management purposes. Additionally, each ATM module contains a Primary and Backup ATM port.

NOTE

If a second AMA is installed on a NIM, BACKUP port, it is considered a redundant port for failover use only and does not support additional segments or load/connection balancing.

Slots are the physical positions within the chassis that accommodate the PE and NIMs. There are five slots available, numbered from the bottom up. Slots 1 through 4 are for the NIMs, while slot 5 is reserved for the PE.

Segments are the logical connections that can be allocated on each of the NIMs. The ATM modules can be configured to support up to 32 segments per module. The ASN-9000 supports a total of 96 segments per chassis. Connections on an ASN-9000 PowerCell ATM Module are for one physical (PHY) port with up to 32 logical segments.

Virtual segments can also be created on ATM modules. Virtual segments are created when multiple segments are assigned to a single ATM port. The PowerCell ATM module can support up to 32 virtual segments on a single ATM port.

A fully populated ASN-9000 can contain up to 128 segments. Only 96 of the segments are supported by the ASN-9000. Segments are numbered according to the following rules:

- Segments are counted from the bottom slot up. Counting of segments begins with the first segment encountered by the software. Within a slot, segments are numbered from left to right.
- The chassis can be populated with ATM modules that total more than the total number of supported segments. However, only the supported number of segments are recognized.
- The last supported segment can be in the “middle” of a module. A segment boundary need not occur on the last segment of a module.
- Any combination of filled and blank slots are supported. In other words, NIMs with 0 segments can be installed between slots with more than 0 segments.

The allocation of segments on each module can be changed with the **`nvram slotsegs[n] set`** command. For example, the allocation of segments on an ATM module can be decreased from the default of 32 segments supported by the module. For instance, if the ASN-9000 is fully populated, four ATM NIMs, the system exceeds the supported number of segments. It is necessary to decrease the number of segments allocated on one or more of the modules. For more information on allocating segments (refer to the *ForeRunner ASN-9000 Software Reference Manual* for information on **`nvram`** subsystem commands).

Available segments can be displayed by issuing the **`system config`** command (refer to the *ForeRunner ASN-9000 Software Reference Manual* for information on **`system`** subsystem commands). This command displays basic chassis configuration information, including:

- The presence of an Accelerator board and whether the IOP on the accelerator is in use.
- The amount of installed DRAM (in megabytes).
- Baud rates of the TTY ports (TTY1/TTY2).
- Slot containing the Packet Engine
- Presence and status of power modules (PMs).
- Number of segments available on each ATM NIM, and the medium type in use by each segment.

1.1.2 Security

The ASN-9000 contains both software and hardware levels of security. At the software level, filters for bridge, TCP, IP, IP RIP, AppleTalk, and IPX RIP and SAP packets can be created. Refer to the *ForeRunner ASN-9000 Software Reference Manual* for more information on applying filters. At the hardware level the ASN-9000 has two levels of security. A Lock/Unlock switch, located on the PE front panel, and Lock/Unlock jumpers, located on the PE circuit board.

When the Lock Switch is set lock (L), a user must enter a valid login ID and password to execute commands that have effect on configuration settings. The position of the Lock/Unlock jumper setting overrides the front panel switch setting. Refer to *Chapter 2, Chassis and Packet Engine* for more information on the Lock/Unlock Switch and *Chapter 6, Installation and Removal Procedures* for instructions on changing the Lock/Unlock Jumper.

1.2 Intelligent Packet Switching

The Packet Engine is a centralized packet processing and forwarding engine that processes packets traveling on configured segments. When a packet is received on a segment destined for a segment on a different module, the packet is forwarded to the Packet Engine and placed in Shared Memory, where it is examined and either dropped or forwarded as applicable. Since the ATM modules are classified as Intelligent NIMs (INIMs), packets received on a segment that are destined for another segment on the same module are not forwarded to the Packet Engine for processing (see Section 1.3.2 for more information on Intelligent NIMs).

1.2.1 Packet-Channel Backplane

The packet-channel backplane is a two-channel backplane that can handle data throughput up to 800Mb/s per channel. The installed ATM NIMs are connected to the Packet Engine through the Packet-Channel Backplane. Refer to Section 2.2 for detailed information on the Packet-Channel Backplane.

1.2.2 Packet Engine (PE)

The Packet Engine (PE) contains 2 CPUs, which can be increased to three with the addition of a Packet Accelerator (see *Chapter 6, Installation and Removal Procedures* for instructions on installing a Packet Accelerator) and accesses the two-channel packet-channel backplane found in the ASN-9000. Refer to Section 2.3 for detained information on the PE.

1.3 Chassis Configuration

The ASN-9000 chassis is designed for easy reconfiguration in response to changing networking needs. Upgrades can be performed using a few standard tools (usually ordinary screwdrivers). Network downtime is minimal while performing the upgrades.

The ASN-9000 chassis is configured by adding NIMs, power modules, and various other performance-enhancing options. The NIMs are connected to the PE by the Packet Channel backplane. Packets and control data sent between the Packet Engine and NIMs pass through this backplane. Power modules provide load sharing and redundancy.

1.3.1 PE Performance Enhancing Options

Performance of the ASN-9000 can be enhanced in several ways. These enhancements can increase the packet processing speed of the packet engine and add redundancy to the system in case of component failure. Depending upon network needs, one or more of the following performance enhancing options can be added (*Chapter 6, Installation and Removal Procedures* contains complete instructions for adding these hardware options).

1.3.1.1 Packet Accelerator Upgrade

The addition of a Packet Accelerator increases the packets-per-second throughput by adding additional RISC CPUs which increase the processing power of the packet engine. Refer to Section 6.2.2 for information about installing the Packet Accelerator.

1.3.1.2 Flash Memory Module Upgrade

The Flash Memory Module is very useful for fast system booting. It allows storing and managing files locally on the packet engine. Refer to Section 6.2.1 for information about installing a Flash Memory Module.

1.3.2 Network Interface Modules

As connectivity needs change, interfaces can be added or changed by adding Network Interface Modules (NIMs). NIMs can be removed and swapped, or rearranged in the chassis while the system is operating.

The ASN-9000 supports Intelligent NIMs which can enhance the overall throughput of the system. Each INIM contains physical connectors and on-board electronics to support ATM protocols. The ASN-9000 can be configured with up to four ATM modules as long as the total number of segments allocated does not exceed the total number of segments supported. The system is designed to balance configuration flexibility and packet throughput. However, if the chassis contains multiple ATM modules, system performance can be optimized by installing them in specific slots. (Refer to *Appendix A, Balancing Bandwidth* for detailed information on optimizing performance.)

The ASN-9000 PowerCell ATM module contains both the ATM physical layer (PHY) and ATM Segmentation and Reassembly (SAR) layers and contains the following hardware features:

- AAL5 support.
- Support for up to 155 Mb/s.
- Traffic and status LEDs.
- Choice of single-mode or multimode fiber on the OC-3 ATM Media Adapter (AMA).
- Optional Backup PHY (redundant) AMA connection.

The PowerCell module connects the ASN-9000 to an ATM switch, which in turn is connected to the ATM network. The PowerCell module is interoperable with FORE Systems' ATM switches. The PowerCell module also can be used with other vendors' ATM switches provided those switches also conform to the ATM Forum standards that the PowerCell module supports. For example, other vendors' equipment must support the ATM Forum standards for LAN Emulation (LANE) 1.0 and User-Network Interface (UNI) 3.0 or 3.1 if planning to use the equipment along with the FORE Systems PowerCell module in a LANE 1.0 network.

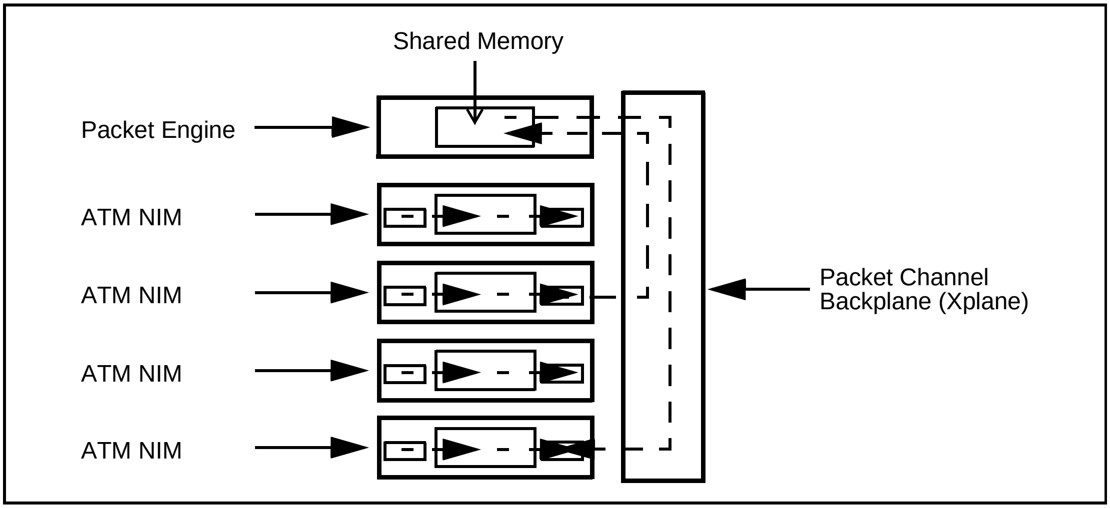

Figure 1.2 - Intelligent NIM Shared Memory Architecture

Figure 1.2 shows how traffic, received on one segment of an ATM INIM that is bound for another segment on the same NIM, is forwarded directly to that segment, bypassing the Packet Engine. All packet processing takes place locally, on the INIM itself. Even packets destined to other INIMs have some pre-processing done to them in order for the packets to be forwarded more quickly by the Packet Engine. Note that this type of processing applies only to bridge, IP, and IPX traffic from one segment to another segment on the same module.

1.3.3 Power Sharing and Redundant Power Modules

The ASN-9000 supports load sharing and redundant power to ensure uninterrupted operation, even in the unlikely event that a power module fails. The ASN-9000 can be equipped with up to two power modules sharing the load across the functioning power module, and redistributing the load if a power module fails. These two features both increase the life span of the power modules and reduce the likelihood of power module failure.

The ASN-9000 power modules are available in a 283 Watt AC version and a 48-volt DC version. When redundant power modules are installed, INIMs can be "hot swapped", allowing configuration changes while the ASN-9000 is operating. Refer to Section 2.4 for more information on power modules.

1.3.4 Status LEDs

Packet Engine or INIM status information, as well as traffic information and connection status for individual segments, is displayed in LEDs located on each module. Status LEDs indicate whether the module has experienced a failure, is performing normal runtime tasks, or is loading software. In addition the Packet Engine status LED remains lit, a "sticky" Alarm LED, indicating that a crash has occurred. Refer to *Chapter 2, Chassis and Packet Engine* for information on the PE status LEDs and *Chapter 3, ATM Interfaces* for information on ATM module and AMA LEDs.

1.4 Software Features

ASN-9000 software features are documented in the *ForeRunner ASN-9000 Software Reference Manual***.** The following are descriptions of some features contained in the *ForeRunner* ASN-9000 software.

1.4.1 DOS-Like File Management System

The packet engine of the ASN-9000 contains a floppy disk and Flash Memory module. Both use a DOS-like file management system. Files created or stored on these devices can be edited using a standard ASCII editor on another device (PC, Macintosh, etc.). Note that this type of ASN-9000 file management system does not support hierarchical directory structures.

1.4.2 Concurrent Command-line Sessions

The ASN-9000 supports concurrent command line sessions. The primary command-line session is always established through a direct connection between a PC or modem and the RS-232 port labeled TTY1 on the packet engine. A second TTY port (TTY2) can be used to establish a second direct connection.

Additionally, up to two in-band TELNET sessions can also be established with the command-line interface. To use TELNET to access the ASN-9000, define an IP interface on the segment attaching the ASN-9000 to the terminal. For more information on command-line sessions, refer to Section 5.2.

1.4.3 Multiple Boot Sources

Software can be loaded entirely from floppy disk or Flash Memory. A combination of boot sources can be configured and saved in a **bootdef** file. After booting, the ASN-9000 can be configured using configuration and environment files. This section provides an overview of these two features.

1.4.3.1 Available Boot Sources

Depending on the ASN-9000 configuration, model and network configuration, configure the ASN-9000 to use one the following boot sources:

- Floppy disk
- Flash Memory Module

If possible, configure the ASN-9000 to attempt loading from both of these sources in either order. If one method fails, the ASN-9000 attempts to load using the other source. The boot order is set using the **`nvram bo`** command. See *ForeRunner ASN-9000 Software Reference Manual* for information on the **`nvram bo`** command.

1.4.3.2 Configuration and Environment Files

When configuring the ASN-9000, define parameters, such as the name, routing interface definitions, and filters. These definitions are not retained across power cycles. However, these definitions can be saved and re-instated at any time using the appropriate ASN-9000 software commands.

The **`system savecfg`** command, for example, creates a file called **`cfg`** and saves it on the floppy disk and/or Flash Memory module. This file contains ordinary ASN-9000 commands such as might be issued to configure the system. When booting the ASN-9000, this **`cfg`** file is read, commands executed, and the ASN-9000 is configured according to its contents. Multiple configurations can be created and loaded as needed.

Parameters for command-line sessions can also be stored and read into the ASN-9000. Session parameters are stored in environment files (**`*.env`**). Like configuration files, environment files contain ASN-9000 commands, and can be loaded during login. Unlike configuration files, environment files apply only to the command-line session in which they are loaded, not to the entire ASN-9000.

1.4.4 Easily Accessible Dump Files

The ASN-9000 is designed for reliable operation under diverse traffic demands. However, in the event the ASN-9000 crashes for any reason, an attempt is made to reboot the system. A dump file is written to the default-device. This dump file is named **`fore.dmp`** and contains information that can be used by FORE Systems TAC to aid in diagnosing the cause of the crash.

FORE Systems TAC can also use the contents of the **`dispcfg`** file to diagnose system problems. The **`dispcfg`** file is a configuration file provided with the system software diskettes. When reading the file (by issuing the **`system readcfg dispcfg`**), the software configuration of the system is displayed on the management terminal.

1.4.5 On-line System Information

At any time during normal operation, commands can be issued to display various hardware information, including:

- Chassis configuration
- Power module status
- Module identification and power requirements
- Current temperature of installed modules
- Segment state, status, and statistics
- Presence of a Packet Accelerator

Hardware information is displayed using commands found in the **`system`** subsystem. Information about the segment state, segment status and segment statistics are available through commands in the **`media`** subsystem. For detailed information about the **`system`** and **`media`** subsystem commands, refer to the *ForeRunner ASN-9000 Software Reference Manual*.

1.4.5.1 Automatic Segment State Detection

Using automatic segment-state detection, the ASN-9000 can detect when the state (up or down) of an attached segment changes. Moreover, when this feature detects a state change, it automatically enables or disables bridging and routing on the changed segment, as appropriate and the change is marked in table displays. Refer to the *ForeRunner ASN-9000 Software Reference Manual* for information on Automatic Segment State Detection.

1.4.5.2 Packet Statistics

Packet statistics for any group or range of segments or ports can be displayed. For example, the number of packets received by a particular segment since the system was last booted can be displayed. For most statistics, two separate counters are maintained:

1.4.5.2.1 Count since last system reset

Begins when the ASN-9000 is booted and continues until it is powered down or re-booted. This counter always shows the count accumulated since the system was last reset.

1.4.5.2.2 Count since last clear

Begins when the ASN-9000 is booted, but can be cleared at any time. When displaying the contents of this counter, the count displayed is the count subsequent to the last time the counter was cleared.

For information on displaying statistics for a specific protocol, refer to the *ATM Services Node 9000 Software Manual* section on the respective protocol type.

1.4.6 Bridging and Multi-protocol Routing

ASN-9000 segments can be configured to bridge (as specified in IEEE 802.1d) as well as route packets according to any combination of the following standard protocols:

- IP
- IPX
- AppleTalk
- DECnet

The ASN-9000 contains an implementation of IP Multicast, which allows multicast routing for bandwidth-intensive applications, such as video conferencing. The same segments can be used to bridge and route packets. In fact, a segment can be configured to not only bridge, but route all four protocols, and perform IP Multicast. For information on configuring segments for bridging and routing, refer to the *ForeRunner ASN-9000 Software Reference Manual.*

1.4.7 Virtual LANs (VLANs)

To manage network segments easier, the ASN-9000 allows creation of Virtual Local Area Networks (VLANs). A VLAN is a network that spans two or more physical segments. VLANs make network configuration changes by allowing the creation and changing of LANs logically, as opposed to physically moving segment cables. The ASN-9000 bridges, rather than routes, packets among segments in a VLAN. Figure 1.3 shows an example of a typical VLAN.

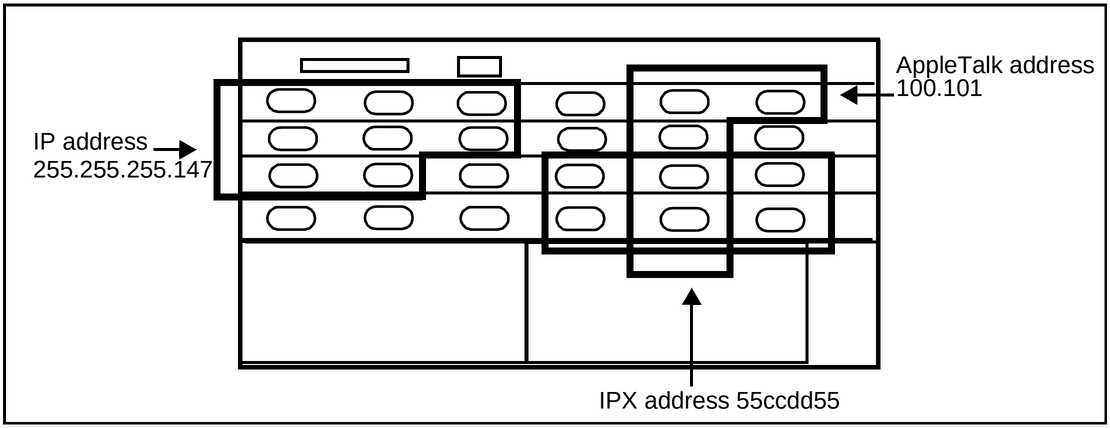

Figure 1.3 - Virtual LAN Examples

As shown in Figure 1.3, a VLAN consists of a group of segments. Each segment in the VLAN has the same interface address. VLANs for IP, IPX, and AppleTalk interfaces can be created. Notice that VLANs can overlap. Refer to the *ForeRunner ASN-9000 Software Reference Manual* for more information on VLAN configuration.

1.4.8 Security Filters

In addition to the Lock Switch and password protection described in Section 1.1.2, logical filters can be defined to control traffic entering and leaving the ASN-9000 on specific segments or interface addresses. Filters can be defined for the following protocols:

- AppleTalk
- Bridge
- TCP and UDP
- IP
- RIP
- IPX RIP and SAP

The ASN-9000 also contains an implementation of IP security as defined in RFC 1108. For detailed information on configuring and applying filters, refer to the *ForeRunner ASN-9000 Software Reference Manual.*

1.4.9 SNMP and MIB Support

ASN-9000 commands can be used to define Simple Network Management Protocol (SNMP) managers and communities. Once the ASN-9000 is configured so that it can be managed through SNMP, ASN-9000 implementations of the following standard Management Information Base (MIBs) can be accessed:

- MIB II (RFC 1213)
- AppleTalk MIB (RFC 1243)
- Bridge MIB (RFC 1286)
- OSPF V2 MIB (RFC 1253)
- Mini-RMON MIB (RFC 1757)

In addition, SNMP can be used to access objects in the ASN-9000 MIB, which is designated as enterprise MIB 390. The ASN-9000 MIB contains objects not contained in the standard MIBs listed above, as well as objects that display configuration information. This includes objects for displaying the current software installed, configuration information about the ASN-9000 chassis, and so on. Refer to the *ForeRunner ASN-9000 Software Reference Manual* for information about configuring SNMP and the standard and ASN-9000 MIB objects.

CHAPTER 2 Chassis and Packet Engine

The *ForeRunner* ATM Services Node 9000 (ASN-9000) is designed to grow with network needs. The ASN-9000 comprises of a 5-slot modular chassis with a two-channel Packet Channel Backplane and up to two Power Module bays. A Packet Engine intelligently processes and forwards packets in and out of the ASN-9000. This chapter describes the following hardware:

- ASN-9000 Chassis (Section 2.1)
- Packet Channel Backplane (Section 2.2)
- Packet Engine (Section 2.3)
- Power Modules (Section 2.4)
- Fan Module (Section 2.5)

2.1 ASN-9000 Chassis

The ASN-9000 incorporates a modular chassis design where most major components can be added or removed at any time. ATM Network Interface Modules (NIMs) are available to further tailor the ASN-9000 to suit networking requirements. Refer to Section 1.3.2 for the available ATM NIM options. The following sections provide additional information on chassis options. Figure 2.11 shows the major components of the ASN-9000.

Figure 2.1 - ATM Service Node 9000 Chassis

As shown in Figure 2.1, the Packet Engine (PE) is installed in the top slot (slot 5) of the chassis. The other four slots accommodate ATM NIMs, configurable modules that provide connections to/from ATM switches. The bottom section of the chassis contains two power module bays. Not shown are the Packet-Channel Backplane and the Fan Module. See Section 2.2 for information on the Packet-Channel Backplane and Section 2.5 for information on the Fan Module.

2.2 Packet Channel Backplane

The Packet-Channel Backplane is the hardware connection between the PE and installed NIMs. The Packet-Channel Backplane enables packets and control data to be passed to and from the PE when processing of packets is required.

Packets forwarded to segments on a NIM are transferred along the Packet-Channel Backplane to the PE for processing. Likewise, packets destined for segments on a NIM are sent from the PE to the NIM along the backplane. The Packet-Channel Backplane transfers data at 800 Mb/s (32 bits @ 25 MHz) per channel providing an aggregate bandwidth of 1.6 Gb/s. Figure 2.2 illustrates the relationship between the two-channel Packet-Channel Backplane, Shared Memory, and NIMs in an ASN-9000. As shown, slots 1 and 2 are served by the Y Packet Channel and 3 and 4 by the X Packet Channel.

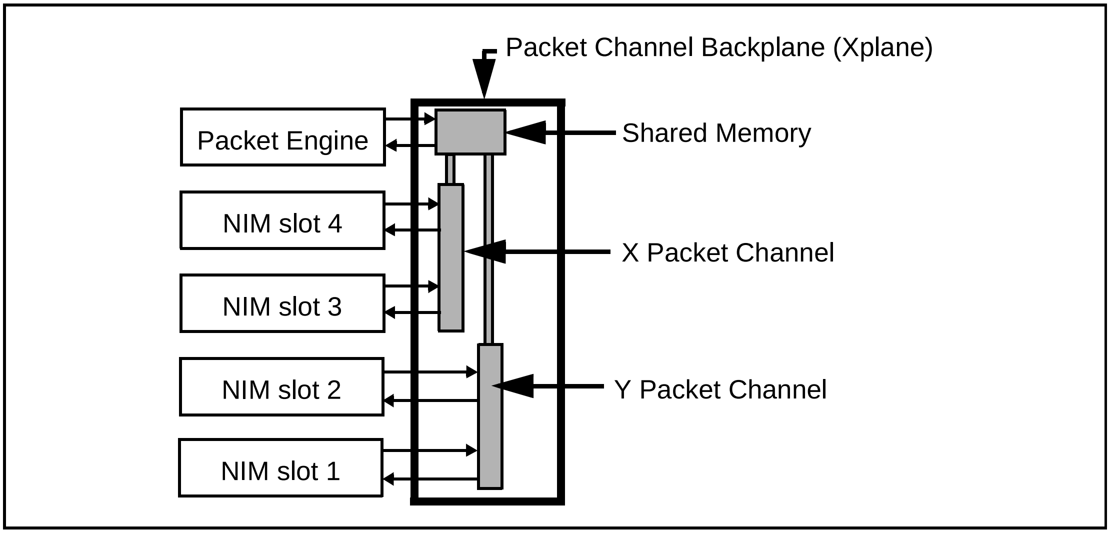

Figure 2.2 - Packet Channel Backplane

Information is exchanged between the PE and the NIMs across the Packet Channels at speeds up to 800 Mb/s per channel (32 bits @ 25 MHz) for a total of 1.6 Gbps, fast enough to support non-blocking operation of a fully-loaded ASN-9000. However, optimal traffic throughput can be ensured by balancing the expected loads on the modules evenly across the Packet Channels. (Refer to *Appendix A, Balancing Bandwidth* for information about balancing bandwidth.) Additionally, the Packet-Channel Backplane contains a Bus Control Module (BCM). The BCM contains clock distribution and bus termination circuits for the Packet Channels. It provides the physical interface to allow the Packet Channels to interface with the PE. The ASN-9000 is shipped with the correct BCM attached, so no maintenance is required.

2.3 Packet Engine (PE)

The Packet Engine (PE) is the centralized packet processing and forwarding engine of the *ForeRunner* ASN-9000. The PE examines packet headers for bridging and routing, then modifies them as required for routing. When a segment receives a packet destined for a segment on a different module, the packet is transferred directly to Shared Memory on the PE. Bridging and routing engines in the PE store all packets and related data structures in Shared Memory. This contributes to high packet throughput because all packet-related data is stored in one place. The PE is shown in Figure 2.3 and contains the following major components:

- Interlock Switch (See Section 2.3.1)
- Status LEDs (See Section 2.3.2)
- Floppy drive (See Section 2.3.3)
- Reset switch (See Section 2.3.4)
- Lock switch (See Section 2.3.5)
- RS-232 ports (See Section 2.3.6)
- Flash Memory module (See Section 2.3.7)
- Temperature sensor (See Section 2.3.8)
- Main memory (See Section 2.3.9)
- Shared memory (See Section 2.3.10)
- Fast-path memory (See Section 2.3.11)
- Boot PROM (See Section 2.3.12)
- ID PROM (See Section 2.3.13)
- Non-Volatile RAM (NVRAM) and Clock (See Section 2.3.14)
- Proprietary Bus Memory Interface ASICs (See Section 2.3.15)
- Central Processing Units (CPUs) (See Section 2.3.16)

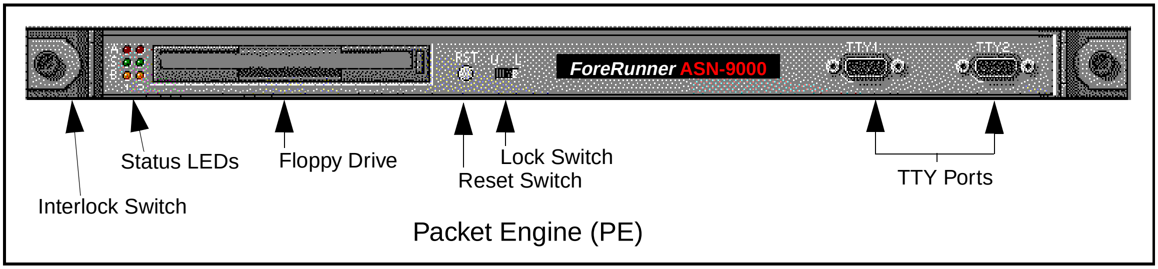

Figure 2.3 - *ForeRunner* ASN-9000 Packet Engine

2.3.1 Interlock Switch

An interlock switch is located under the left circuit board handle. To ensure that the PE does not vibrate loose and open the interlock switch, it is necessary to firmly secure the PE using the front panel screws. In the event that the interlock switch opens, the PE shuts down and all connections to the ASN-9000 are lost.

2.3.2 Status LEDs

A series of Status LEDs are provided on the PE. These LEDs provide a visual status of what is happening within the PE. Two sets of LEDs provide status information for one of the two RISC processors on the PE. The left LED monitors the status of the main CPU (MCPU). For information on the RISC processors on the PE, see Section 2.3.16. Table 2.1 describes the function of the status LEDs.

Table 2.1 - Packet Engine Status LEDs

Label	Color	Indicates…	
A	Red	**Alarm**	Indicates that a system crash has occurred. One or all LEDs remain lit until the ASN-9000 is reset. To reset the ASN-9000 press the reset (RST) switch or switch the power supplies off and then on.
S	Green	**Status**	Indicates CPUs are functioning normally. If the left LED goes out during normal operation, there ***might*** be a problem in the Packet Engine.
B	Amber	**Boot**	Indicates the ASN-9000 is booting. These LEDs are lit only during the booting process and go out as soon as booting is complete.

2.3.3 Floppy Disk Drive

The floppy disk drive is a 3-1/2" high density (HD) drive. The floppy disk drive accepts 1.4MB MS-DOS formatted diskettes. Various file management tasks including displaying, copying, renaming, and removing files can be performed using the floppy disk drive as a source or destination of the file. However, the ASN-9000 file system does not support hierarchical directory structures.

Generally, the floppy drive is only used to perform software upgrades, save changes to, read a configuration or environment file, or to boot the system. The floppy drive is not used during normal, unattended operation. However, if the system is configured to boot from the floppy disk, a diskette with the proper image(s), must be present in the floppy disk drive at all times.

2.3.4 Reset Switch

The reset switch is located in the center of the front panel to the left of the Lock Switch. When pressed, it performs a 'cold' restart of the system. During a cold restart, the PE conducts a power-on self-test to check various hardware components.

When the reset switch is pressed and the ASN-9000 reboots, it boots according to the boot preference(s) specified in nvram. The PE uses files in the Flash Memory Module, on floppy disk, or via a TFTP server (network booting) to configure the ASN-9000 for runtime operation, depending on the boot order in nvram. When shipped from the factory, the ASN-9000 software is configured to boot from the Flash Memory module. Refer to the *ForeRunner ASN-9000 Software Manual* for information on changing the boot source in nvram.

2.3.5 Lock Switch

The PE features a Lock Switch, located on the front panel to the right of the reset (RST) switch. The Lock Switch, when set to L (Locked) locks the user interface so that a login ID and password are required before a user can access the command-line interface. The switch is disabled or set to Unlocked (U) at the factory. When set to U, anyone capable of establishing a connection to the ASN-9000 can access the user interface.

The PE also contains a Lock Switch Jumper which can be used to override the Lock Switch. Refer to *Chapter 6, Installation and Removal Procedures*, for procedures on changing or setting the Lock Switch and Lock Switch Jumper.

When the Lock Switch (or Lock Switch jumper) is set to Locked, a password is required to obtain access to the ASN-9000. Two levels of access are available; root and monitor. The password associated with each level can be changed. Refer to the *ForeRunner ASN-9000 Software Manual* for procedures on changing or setting passwords.

2.3.5.1 Root

Root access allows the user unrestricted control of the ASN-9000, including issuing commands that clear statistics and change the configuration.

2.3.5.2 Monitor

Monitor access allows the user to display information, but does not allow statistics to be cleared or configuration settings to be changed.

2.3.6 RS-232 Ports

The PE supports two TTY ports, labeled TTY1 and TTY2. Each port provides an RS-232 connection to the ASN-9000. These ports are generally used to attach management terminals or modems. Each port supports the following asynchronous modem-control lines: RXD, TXD, DCD, DTR, RTS, and CTS. Baud rates of 1200, 2400, 4800, 9600, or 19200 are supported on each RS-232 port.

To ensure session security, the TTY ports use data carrier detect (DCD). If the terminal or modem connected to the TTY port is supplying the DCD signal, the ASN-9000 monitors that signal. If DCD is dropped, the software logs the user out of the session. This prevents other terminals or modems from connecting to the session.

If the terminal or modem attached to the ASN-9000 does not supply a DCD signal, the TTY port can still be used. The PE has “weak pull-up” resistors that supply the DCD signal internally. (However, if the cable contains another signal where the ASN-9000 expects to find the DCD signal, the cable might prevent proper operation of the TTY port. Refer to Appendix B for the pinouts of the TTY1 and TTY2 ports.)

When the ASN-9000 boots, it automatically begins a command-line session on the terminal or modem connected to the TTY1 port. Note that the first time logging on to the ASN-9000, the modem or management terminal attached to TTY1 must be set to 9600 baud.

See Section 5.2 for instructions on attaching the management terminal or modem to the TTY1 port. This section also describes how to assemble an RS-232 cable to connect to the TTY1 port.

2.3.7 Flash Memory Module

The PE can be ordered with (or upgraded to use) a 4MB Flash Memory Module. This module stores configuration settings and boot information and is required if not booting over the network. The Flash Memory module can be formatted and configured through a tftp session with the switch. The Flash Memory Module allows for fast system booting. See Section 8.3 on page 8-16 for information about installation and removal of the Flash Memory module.

2.3.8 Temperature Sensor

A temperature sensor is available on each module installed in the ASN-9000 chassis. The temperature sensor reads the temperature of the module, within an accuracy of plus or minus 0.5° C. The **system temperature** command can be issued at any time to read the current operating temperature of a particular module or all installed modules. (Refer to the *ForeRunner ASN-9000 Software Reference Manual* for more information on displaying the temperature.)

2.3.9 Main Memory

Each Packet Engine ships with 32MB of main memory in the form of dynamic random access memory (DRAM). This main memory is used by the bridging and routing engines in the software. This standard memory configuration supports all protocols supported by the ASN-9000. Including Bridging, IP routing, IP Multicast, IPX, AppleTalk, DECnet, and Bridge MIB.

2.3.10 Shared Memory

The Packet Engine contains Shared Memory that provides 800Mb/s of bandwidth, more than enough to support a fully-loaded ASN-9000. The ASN-9000 is equipped with 2MB Shared Memory.

The RISC CPUs and Packet Channels use the Shared Memory to store packets and related data structures. Because all packet-related data is stored in one place, the system can maintain a high packets-per-second throughput.

2.3.11 Fast Path Memory

In addition to their own on-chip caches, each CPU can access private “fast-path” memory that stores the most performance-critical code and data. Additional resources that can be accessed by both CPUs are described in the following sections. These additional resources are used mostly by the MCPU.

2.3.12 Boot Programmable Read-Only Memory

The Packet Engine also contains a Boot Programmable Read-Only Memory (Boot PROM) that contains software used by the Packet Engine when booting the ASN-9000. Software commands can be issued to the Boot PROM to perform configuration tasks such as specifying a boot source and installing software upgrades. Refer to *Chapter 7, Boot PROM Commands* for a description of the boot PROM commands. The command prompt for the boot PROM in a PE is shown as `<PROM-7pe>`, while in the PE2 it is shown as `<PROM-8pe>`.

2.3.13 ID PROM

The Packet Engine, and all NIMs, have an ID PROM located in a reserved area in the Boot PROM that contains identification information of the module, and lists the maximum amount of current required to power the module. The ID PROM lists the module's serial number, model number, hardware revision, and other factory-issued information. To display the contents of the ID PROM use the **system idprom|ipd** command. (Refer to *ForeRunner ASN-9000 Software Reference Manual* for more information on the ID PROM command.)

2.3.14 Non-Volatile RAM (NVRAM) and Clock

The Non-volatile RAM (NVRAM) is a battery-operated 8K CMOS RAM and time-of-day clock. NVRAM maintains the system time and date and contains configuration information such as the baud rates of the TTY (RS-232) ports, the ASN-9000 system name, the boot source, TFTP file server address, and allocated slot segments

NVRAM can be configured to contain additional configuration information used in some implementations of network booting. Refer to *ATM Services Node 9000 Software Reference Manual* for information on this topic.

NVRAM can be accessed from either the PROM command prompt or the run-time command prompt. Refer to Section 7.2.8 for information about the Boot PROM commands available to configure the NVRAM.

2.3.15 Proprietary Bus-Memory Interface ASICs

FORE Systems' proprietary BMW (Bus Memory Wide) ASICs and Bus-Memory Interface (BMI) ASICs provide multiple ports for Packet Channels and CPUs to access Shared Memory. The type of ASICs on the Packet Engine varies depending on Packet Engine.

Four BMI ASICs provide the following support: Two Packet Channel ports (X and Y), each providing 800Mb/s of peak bandwidth. Two CPU ports (CPU1 and CPU2), connecting to the MCPU and IOP CPUs.

Access to Shared Memory ports is prioritized. The CPU ports have the highest priority, followed by the Packet Channel ports.

2.3.16 Central Processing Units

The basic PE contains two RISC CPUs, each with specialized functions. One functions as an Input/Output Processor (IOP) to handle real-time processing for network interface chips, including initialization, error handling, packet reception, packet transmission, and buffer management. The other, Main CPU (MCPU), runs packet forwarding algorithms, used for

MAC-layer bridging and multiprotocol routing. In addition, this CPU runs management software, including an SNMP agent. When a Packet Accelerator is used, a second MCPU and a second IOP are added to the PE.

2.4 Power Modules

The ASN-9000 supports a 283 Watt AC and a -48 Volt DC Power Module. The ASN-9000 supports redundant power modules and load sharing. Load sharing reduces wear on the power modules and results in longer power module life. The AC power module plugs into a standard grounded three-prong outlet. The DC power module requires connecting of a -48 Volt source to a front panel connector. The power backplane connects the power modules to the rest of the system. The power module contains an internal fan to provide cooling for the power module components. For more information on working with the power modules, refer to *Chapter 6, Installation and Removal Procedures*. The following sections discuss the power modules.

2.4.1 Load Sharing

Many configurations require only a single power module to run, but can use a secondary power module for redundancy (backup) and load sharing. When power modules load share, they participate equally in providing power to the ASN-9000. Load sharing improves the reliability of each power module participating in the load sharing. In addition, if one power module ever fails, the entire load is immediately assumed by the remaining power modules. As long as the remaining power module is providing sufficient current to run the ASN-9000, it continues to operate without interruption.

When a redundant power module is operating in an ASN-9000, either power module can be removed without interfering with the operation of the system. As long as the chassis contains the minimum number of power modules required to support its configuration, it continues operating normally.

When a single power module is used, it must always be installed in the left power module bay. A protective coverplate must be installed in the unused bay. (Operating the system with an uncovered power supply bay affects internal cooling and can void the warranty.) In the event of a short circuit or other overload condition, all power modules automatically shut down to protect the ASN-9000 from damage.

2.4.2 Live Insertion

In addition to removing a redundant or failed power module, a new power module can be inserted while the chassis is operating. This is known as live insertion. As soon as AC current is applied to the inserted power module, it begins to load share with the power modules in the chassis. Refer to *Chapter 6, Installation and Removal Procedures* for instructions on inserting a power module. AC or DC power modules can be simultaneously installed in the ASN-9000 chassis.

2.4.3 Power Modules

There are two power modules available for the ASN-9000. One is a 283 Watt AC Power Module and the other is a -48 Volt DC Power Module. These power modules are interchangeable, interoperable and backwards compatible. The power required by the ASN-9000 is dependent on the number of NIMs installed and the current that each NIM draws.

The AC and DC power modules each contain three LEDs to provide a display of the current operating condition of the module. Table 2.2 lists the LEDs on the AC and the DC power modules.

Table 2.2 - Power Supply LEDs

Label	Color	Indicates…
AC (DC on the DC Power Supply)	Amber	Power module is receiving current from the power source. If this light is on, but the following two lights are off, a short circuit or other overload condition has occurred.
5V	Green	Power supply is supplying +5-volt power.
12V	Green	Power supply is supplying +12-volt power.

2.4.3.1 283 Watt Power Module

The maximum output current of the 283 Watt power module is 35A at +5 volts DC and 9A at +12 volts DC. However, for conservative operation in non-redundant configurations, FORE Systems recommends that the module be derated to approximately 90% of its full capacity—32A at +5-volt and 8A at +12-volt. Using the power modules at the derated capacity reduces the long-term stress on the modules and improves reliability.

The AC power module transforms AC current into the +5- and +12-volt DC current required by the ASN-9000. Each power module requires an input voltage of 85–132 volts AC (or 180–264 volts AC when used in countries using 220-volt AC standard) at 47–60 Hz.

The AC power module runs on a standard 110-volt AC or 220-volt AC power source. The power module automatically detects the input voltage, so no jumpers or switches are needed when setting up for an alternative power source. The power module is shipped with a three-wire power cable that matches the power receptacle used in the destination country. The wiring used to connect the ASN-9000 to the power source should be capable of carrying at least 10 amps.

The AC power cord plugs into a receptacle on the front of the power supply. When more than one power module is installed, each requires its own power cable.

A power module must be installed in the primary Power Module bay before booting the ASN-9000. In an ASN-9000, the left bay houses the primary supply. The other bay can house a secondary power module. The minimum number of power modules required to run the ASN-9000 depends upon its configuration. For information about power requirements, refer to *Chapter 4, Safety and Environment Requirements*.

2.4.4 DC Power Module

The DC power module transforms DC current into +5-volt and +12-volt DC current needed by the ASN-9000. Each power module requires an input voltage of 40–60 volts DC. The maximum output current of the power module is 35A at +5 volts DC and 9A at +12 volts DC.

The DC power cable consists of six wires: two black (+48V), two red (-48V), and two green (safety ground). In a normal telephone system, the +48-volt battery terminal is connected to an earth or safety ground, while the -48-volt battery terminal is floating.

When shipped from the factory, one end of the cable contains a keyed connector that plugs into the DC power module. The other end of the cable has no connector. Connect the wires to the DC power source. The ends of the wires are stripped to simplify the installation. The power switch on the DC power module is actually a circuit breaker. When the switch is set to the ON position (marked |), the circuit is closed. When the switch is set to the OFF position (**O**), the circuit is open. Figure 2.4 shows the control panel of the DC power module. Notice that the LEDs are labeled differently from the AC power module, and the connector for the power cable is different.

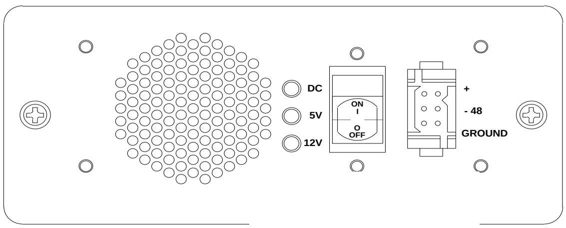

Figure 2.4 - DC Power Supply

Chassis and Packet Engine

2.5 Fan Module

The ASN-9000 is equipped with fan modules to help dissipate heat and keep the NIMs and Packet Engine at optimal operating temperatures. Each ASN-9000 contains one fan module for every five slots of chassis. The fan module contains three fans providing a steady flow of air to the Packet Engine and NIMs. In the event that one fan in a module fails, the remaining two fans can provide adequate cooling. The fan module is designed for easy removal or insertion, and the entire fan module can quickly be replaced, even while operating. Refer to Section 6.3 for procedures on replacing a fan module.

CHAPTER 3 ATM Interfaces

Asynchronous Transfer Mode (ATM) is a high-performance technology for internetworking. ATM uses fixed-size cells to transport data, whereas current LAN technologies use packets that vary in size. The *ForeRunner* ASN-9000 provides ATM connectivity through the ASN-9000 PowerCell ATM Module and ATM Media Adapters (AMAs). This chapter describes the ASN-9000 PowerCell hardware features and the available AMAs.

3.1 ASN-9000 PowerCell ATM Module

The ASN-9000 PowerCell is an Intelligent NIM (INIM) that contains on-board CPUs to handle packet processing so that Packet Engine (PE) resources are not consumed when a cell is received or transmitted on the same module. The ASN-9000 PowerCell module contains the ATM physical layer (PHY) and ATM Segmentation and Reassembly (SAR) layers. Each ASN-9000 PowerCell can support up to 32 logical segments.

ATM network connections are made by attaching the ASN-9000 PowerCell module to an ATM switch, which in turn is connected to the ATM network. The ASN-9000 PowerCell module is interoperable with FORE Systems' ATM switches and can be used with other vendors' ATM switches provided those switches conform to the ATM Forum standards that the ASN-9000 PowerCell module conforms. The ASN-9000 PowerCell module conforms to ATM Forum standards for LAN Emulation (LANE) 1.0 and User-Network Interface (UNI) 3.0.

Some ASN-9000 PowerCell modules allow redundant connections to the ATM network. Redundant connections can be provided by installing a redundant PHY that automatically takes over if the connection to the primary PHY fails.

The FORE Systems ASN-9000 PowerCell modules contain the following hardware features:

- AAL5 support.
- Support for up to 155 Mb/s.
- Choice of OC-3, UTP or DS-3 interfaces.
- Single-mode or multimode fiber on the OC-3 interface.
- Traffic and status LEDs.
- Optional backup PHY.

3.1.1 ASN-9000 PowerCell

The ASN-9000 PowerCell can contain one or two ATM Media Adapters (AMAs). Each AMA provides a single physical port for connection to an ATM switch. The ASN-9000 PowerCell can be installed in any available slot in the ASN-9000 chassis. The ASN-9000 PowerCell can be configured to support up to 32 logical segments on each port. Each logical segment can be configured for one of the following protocols:

- LANE (LAN Emulation) 1.0.
- RFC-1483 Encapsulation over PVC (Permanent Virtual Circuit).
- Classical IP over ATM (RFC 1577).
- FORE IP.

Figure 3.1 shows the ASN-9000 PowerCell front panel. The ASN-9000 PowerCell shown in Figure 3.1 contains both a Primary and Backup OC-3 AMA.

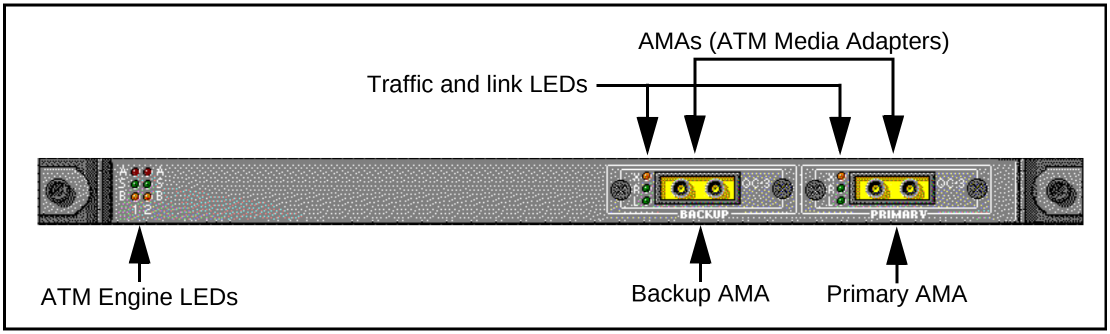

Figure 3.1 - ASN-9000 PowerCell

The ASN-9000 PowerCell contains a single Segmentation and Reassembly (SAR) chip and one or two Physical Layer (PHY) chips. Each PHY is contained on the primary or backup AMA. The ASN-9000 PowerCell ships with a single AMA (primary only). If the ASN-9000 PowerCell is ordered with only a primary AMA, a second can be installed later as a backup. Section 3.1.1.2 describes the operation of the backup AMA.

The AMA types differ according to the physical interface. The ASN-9000 PowerCell AMAs are described in the following sections. Refer to the *ForeRunner ASN-9000 Software Reference Manual* for information on the commands to configure the ATM ports.

3.1.1.1 ATM Engine LEDs

The ASN-9000 PowerCell modules contain LEDs that provide status of the ATM Engine, the ATM link and traffic LEDs. (See Figure 3.1.) The ASN-9000 PowerCell's ATM Engine LEDs are located on the left side of the ASN-9000 PowerCell. The module has two LEDs of each type listed in Table 3.1.

Table 3.1 - ASN-9000 PowerCell ATM Engine LEDs

Label	Color	Indicates…
A	Red	Alarm. Indicates if the PowerCell module has crashed and remains lit until the ASN-9000 is rebooted.
S	Green	The ATM CPUs are functioning normally. If both of these LEDs go out during normal operation, there might be a problem in the ATM Engine. (It is normal for either of the LEDs to be dark sometimes.)
B	Amber	The ASN-9000 PowerCell module is booting. These LEDs flash when the module is booting, then go dark as soon as the module is finished booting.

3.1.1.2 Backup Port

In the ASN-9000 PowerCell module contains two ports, the primary port is used for network traffic. The backup port automatically takes over if the link on the primary port fails. For the backup port to automatically take over traffic handling responsibilities in the event of a failure of the primary it must be properly configured and it should be connected to a different switch than the primary port. Refer to Section 3.1.2.1 for information on configuring primary and backup AMAs.

The ASN-9000 PowerCell allows ports to be installed or removed separately. Therefore, if the ASN-9000 PowerCell contains only one port and a backup port is to be added, an additional port can be installed on the ASN-9000 PowerCell module. Refer to *Chapter 6, Installation and Removal Procedures* for procedures on installing a backup AMA.

3.1.2 Configuring ATM Modules

There are several required steps to properly configure the ATM module to support primary and backup adapters, emulated LANs (ELANs) and ATM services. the following sections briefly describe the commands necessary to configure these interfaces. Refer to the *ForeRunner ASN-9000 Software Reference Manual* for detailed information on these commands.

3.1.2.1 Primary/Backup AMAs

Use the `active-ama|aa` command found in the `atm` subsystem to configure the active and backup ports. The syntax for this command is:

active-ama|aa cset p[rimary]|b[ackup] <slot>|all

Additionally, if primary and backup PHY adapters are installed, a link timer setting should be set to control the length of time the system waits before shifting to the backup PHY. The syntax of this command is:

active-ama|aa cset linktimer|lt <time_sec> <slot>|all

3.1.2.2 ELAN Name

Before configuring services on the ATM adapters, it is necessary to assign an Emulated Local Area Network (ELAN) name to each ATM slot being configured. The `elan add` command is used to configure an ELAN name. The `elan add` command can be found in the `atm/lane` subsystem. The syntax for this command is:

elan add <segment> <elan-name> [la <les-atm-address>|lu <lecs-atm-address>]

3.1.2.3 ATM Services

Use the `les add` command found in the `atm/lane` subsystem to setup ATM services on a PowerCell module containing only a primary AMA. The syntax for this command is:

les add <les-elan-name> <slot> <les-SELbyte> <bus-SELbyte>|<bus-atm-address>
[[rg=]<rate-group>] [-type (ethernet|token-ring)] [-mtu (1516|4544|9234)]

Use the second variation of the `les add` command to configure ATM services on a system containing primary and backup AMAs. The syntax for this command is:

```
les add <les-elan-name> <slot> <Service-ID> [[rg=]<rate-group>]
     [-type (ethernet|token-ring)] [-mtu (1516|4544|9234)]
```

3.1.3 ATM Media Adapters

The ASN-9000 PowerCell module supports ATM Media Adapters (AMAs) supporting OC-3 (single-mode and multimode), UTP and DS-3 ATM physical interfaces. The following paragraphs describe each of these AMA interface modules. Refer to *Chapter 6, Installation and Removal Procedures*, for procedures to remove or install Media Adapters.

3.1.3.1 OC-3 AMA

The OC-3 AMA is available in both single-mode and multimode versions and provides bandwidth up to 155 Mb/s. The OC-3 AMA connects to the network using a pair of fiber-optic cables. The type of cable and connectors for the single-mode differs from those for a multimode adapter. Figure 3.2 shows an OC-3 Multimode AMA front panel. The front panel indicates whether it is single-mode (SMF) or multimode (MMF). The front-panel LEDs (X, R, and L) are described in Table 3.2. The OC-3 AMAs support SONET and SDH modes of operation.

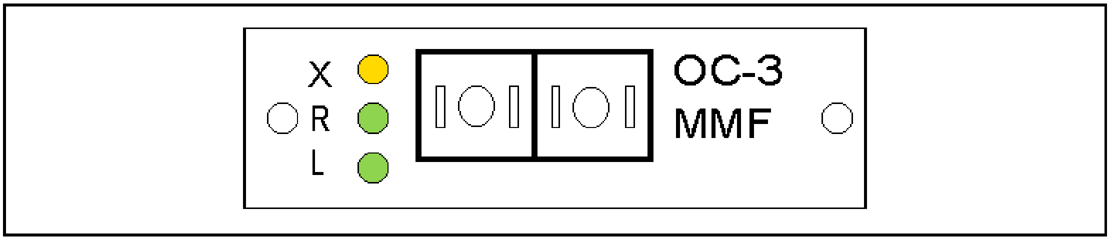

Figure 3.2 - OC-3 AMA

3.1.3.2 UTP AMA

The UTP AMA provides bandwidth up to 155 Mb/s. The UTP AMA connects to the network using twisted-pair cable and an RJ-45 connector. Figure 3.3 shows the UTP AMA front panel. The front panel indicates that it is a UTP module. The traffic LEDs (X, R, and L) on the AMA are described in Table 3.2. The UTP AMA also supports SONET and SDH modes of operation.

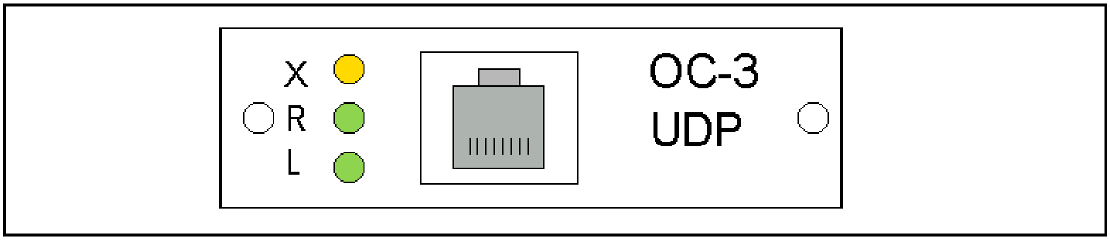

Figure 3.3 - UTP AMA

3.1.3.3 DS-3 AMA

The DS-3 AMA provides up to 45 Mb/s of bandwidth and connects to the network using a pair of 75-ohm BNC-type coaxial cables. Figure 3.4 shows the DS-3 AMA front panel. The front-panel LEDs (X, R, and L) are described in Table 3.2. The DS-3 AMA, when available, supports cbit-adm, cbit-plcp, m23-adm and m23-plcp modes of operation.

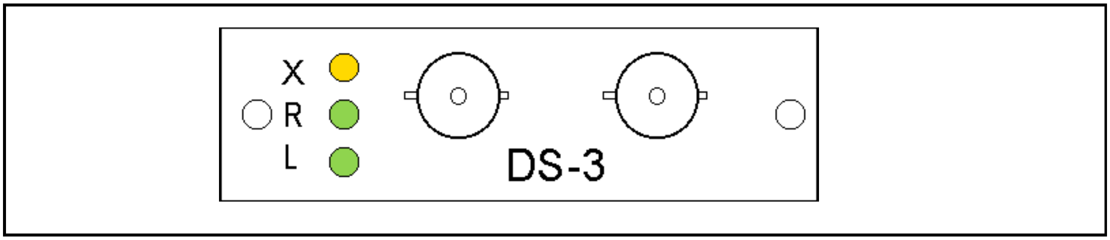

Figure 3.4 - DS-3 AMA

3.1.4 AMA Traffic and Link LEDs

Each of the AMA modules contain front-panel LEDs that provide traffic information and link status for the AMA. Table 3.2 describes the LEDs and what they indicate.

Table 3.2 - ASN-9000 PowerCell Traffic and Link LEDs

Label	Color	Indicates…
X	Green	Transmit. Illuminates during runtime operation. Indicates that the ASN-9000 PowerCell module is transmitting cells to the ATM network. If this LED goes dark, the ASN-9000 PowerCell module is not sending.
R	Green	Receive. Illuminates during runtime operation. Indicates that the ASN-9000 PowerCell module is receiving cells from the ATM network. If this LED goes dark, the ASN-9000 PowerCell module is not receiving.
LNK	Amber	Link status. Displays the link status of the ATM connection. When glowing, the ATM link is “good.” The link-status LED goes dark if the cable is removed. If the cable is attached but the LED is still dark, the transmit and receive cables may be plugged into the wrong connectors, or a problem could exist in the switch attached to the cable or in the cable itself.

CHAPTER 4 Safety and Environment Requirements

This chapter provides a summary of the safety and handling precautions for handling the ASN-9000 and its components. The following safety and handling guidelines are discussed:

- Electro-Static Discharge (ESD)
- Avoiding personal injury
- Guarding Against Damage
- Preventing Damage to Connector Pins
- Securing Thumbscrews
- Care of Fiber-Optic Systems and Cables

Additionally, this chapter discusses the environmental and power requirements for the proper use of the ASN-9000.

4.1 Electro-Static Discharge

Electronic components can be damaged through improper handling. One of the most common, although unintentional, types of mishandling is Electro-Static discharge (ESD). ESD can permanently damage electronic components. ESD straps should be worn when performing the hardware procedures explained in this chapter. Carefully read all of Section 4.3 for details. ESD can occur when the equipment being handled and the individual handling the equipment are at different voltage potentials. When coming into contact with the equipment, the difference in potential can cause energy to be passed from the individual to the component, delivering a shock. The human body is a good conductor of electricity and can deliver shocks containing thousands of volts. In fact, most people perceive a static shock only when the voltage of the shock is at least 6,000 volts. However, many electronic components can be damaged by shocks as low as 2,000 volts.

4.2 Avoiding Personal Injury

Use care and common sense when handling modules. Improper handling of can result in damage to the components or personal injury. To avoid personal injury:

- Do not immerse components in water.
- Do not stand on a wet surface while inserting or removing modules.
- Always cover unused slots or bays with the supplied cover plates. Never place tools, or any body part inside empty power module bays or module slots.

4.3 Guarding Against Damage

The following precautions should be taken when handling modules or components to guard against damage:

- Wear an anti-static wrist guard. Make sure the wrist guard directly touches the skin. To insure against ground faults, use a wrist guard that has a 1MΩ (one megohm) resistor.
- Always store modules in their original packaging.
- Never operate the system with exposed power module bays or NIM slots. Operating the unit without cover plates installed over unused bays or slots voids the warranty.
- Handle the modules only by their edges. Never directly touch components on the modules.
- Never remove a module from its protective packaging or from a chassis until the chassis and the work surface are properly grounded. If the work surface is metallic, ground it by attaching a wire from the surface to the electric ground in the building. If the work surface is not metallic, use a ground-conductive rubber mat as the work surface.

NOTE Low humidity levels can increase the danger of ESD. Use extra caution if the system is in a low-humidity environment.

- After the chassis and any loose components are grounded, touch the chassis or work surface containing the component, ***before*** touching the component itself. In this way, any charge is neutralized before it can damage the component. Note that the chassis or other surface ***must*** be grounded for this to be effective.

4.4 Preventing Pin Damage

Use care when handling modules that have connector pins. Modules such as the Packet Channel Backplane and the power backplane contain small pins that plug into headers in other modules. These pins can be bent if mishandled, or excessive force is used to seat the modules'.

Pin damage caused by mishandling is not covered by warranty. If a pin is accidentally bent, to prevent the pin from becoming broken, carefully bend it back into position before attempting to seat the module.

4.5 Tightening Thumbscrews

Always use the appropriate screwdriver to tighten thumbscrews on the modules. If a screwdriver is not used to tighten the thumbscrews, the modules can vibrate loose when installing cables or moving adjacent modules and cover plates. The thumbscrews on the Packet Engine and NIMs require a regular flat-head screwdriver; the power modules require a #2 Phillips-head screwdriver.

4.6 Care of Fiber-Optic Systems and Cables

In addition to the general precautions discussed above, fiber-optic systems require additional precautions. Always use care when connecting fiber optic cables. Although they appear to look like standard copper cables, they are delicate. Avoid repeated sharp bending of fiber optic cable since it can cause micro-cracking of the glass fiber. Be particularly careful of the open ends of the uncovered connectors. Make sure that the connector surfaces are not dragged along the floor or dropped onto hard or abrasive surfaces. The best practice is to keep the factory supplied dust covers on all unused fiber connectors and optical components.

4.7 Environment Requirements

This section describes environmental requirements that should be followed, operating temperature ranges, and describes how to ensure proper air flow for cooling.

The ASN-9000 is designed to operate within a temperature range of 0° to 40° C (32° to 104° F) and at 10 to 90 percent relative humidity, non-condensing. The corresponding storage requirements are –20° to 55° C (–4° to 131° F) and 90 percent maximum relative humidity, non-condensing.

To ensure adequate air flow for cooling, at least a 3" clearance should be available on both sides and in front. Operating without adequate clearance for cooling voids the warranty.

4.8 Power Requirements

This section details the power requirements and components. These requirements vary depending on configuration. This section describes redundant and non-redundant power configurations, discusses the number of power modules required in non-redundant and redundant configurations, and lists the power requirements for the +5-volt and +12-volt power modules.

Power requirements are determined by the number of populated slots. The ASN-9000 supports 5 NIM slots and two power modules. The following sections identify the power requirements so that the power produced by the power modules is sufficient to support the installed configuration. Up to two power modules can be utilized to provide load sharing and redundancy. The following sections also specify the power requirements of the ASN-9000, and the power produced by the 283 Watt power module.

The number of power modules required depends upon the configuration—both the number and types of installed modules and whether redundant power operation is desired. In any case, the first step in determining the number of power modules needed is to determine the total power requirements of the configuration.

ASN-9000 components consume power at two different voltages, +5 volts and +12 volts. Power needs are determined based on the greater of the +5-volt and +12-volt power requirements. The requirements are identical regardless of whether the current is being supplied by AC or DC modules.

4.8.1 Voltage/Current Requirements

Power requirements are calculated by adding the current requirements of installed system components. Technically, the actual power requirement in watts is the supply voltage times the current requirement in amperes, but only electrical engineers are interested in this sort of distinction.

Table 4.1 lists the current requirements, in amperes (A), required from the +5 volt and +12 volt power of each component. The total +5 volt current required by a particular configuration is determined by adding the +5 volt current requirements of all installed components, being careful to account for multiple instances of each module type. The only +12 volt current required is for the Fan Module.

Table 4.1 - ASN-9000 Voltage / Current Requirements

Component	+5V	+12V
ASN-9000 PowerCell ATM Module with 1 PHY (AMA)	7.5A	
ASN-9000 PowerCell ATM Module with 2 PHYs (AMAs)	8.0A	
Packet Engine	10.0A	
Fan Module		1.0A

4.8.1.1 Redundant and Non-Redundant Power Configurations

The ASN-9000 can be configured to provide redundant or non-redundant power. FORE Systems recommends the use of redundant power. Redundant power provides backup power in the event a power module failure. FORE Systems' redundant power design allows the ASN-9000 to continue running without interruption in the event a power module fails or is removed, or even if someone trips over one of the power cords. In addition, live insertion of NIMs can be performed only if a redundant power module is present.

Redundant power ensures that if a power module fails, the system continues to operate normally. Since the system continues operating, unlit LEDs on a bad power module identify where the problem is so that the problem can easily be corrected.

4.8.1.2 Determining the Number of Nonredundant Power Modules

Two types of power modules are supported. One AC module, which produces 283 Watts, and a 48-Volt DC module. The DC power module produces the same current as the 283 Watt power supply.

The 283 Watt AC and 48 Volt DC power modules are rated to continuously deliver 35A @ +5 volts and 9A @ +12 volts. However, for conservative operation in nonredundant configurations, FORE Systems recommends that power modules be de-rated to provide approximately 90% of full capacity when calculating current usage. De-rating the power usage reduces long-term stress on the modules and improves reliability.

Table 4.2 shows the capacity of the 283 Watt power module. To determine the power requirements, add the amount of current the installed NIMs draw and divide the number by the current capacity of the power module to get the number of power modules needed. For example, in Table 4.1, the total +5 volt current requirement for a system with one ASN-9000 PowerCell containing two PHY adapters is 16 Amps. The total +12 volt current requirement is 1 Amp. The number of power modules required for a nonredundant configuration for either 16 Amps at +5 volts and 1 Amp at +12 volts is 1)

Table 4.2 - Power Module Requirements

Module Type	+5V Current (in Amps)	+12V Current (in Amps)	Nonredundant	Redundant
283Watt	0 - 35	0 - 9	1	2
	35.1 - 70		2	2

The number of modules required is the maximum of the numbers determined using Table 4.1. In Table 4.2, if the total +5 volt current requirement was 35A instead of 16A, the number of modules required for a conservative nonredundant configuration would become 2 instead of 1. The number of modules required to satisfy the +5 volt requirement is now 2, so use 2 modules even though the +12 volt requirement is still satisfied.

4.8.1.3 Determining the Number of Redundant Power Modules

The fourth column shows the number of modules required in a redundant configuration as a function of the +5 volt and +12 volt current requirements. The total +12 volt current requirement is 1Amp, and the total +5 volt current requirement is 16A. Using the fourth column, the number of power modules required to satisfy the current requirement is 2.

During normal operation in a redundant configuration, each module operates well below its maximum capacity. This is true because the power system provides load-sharing, so that each installed module handles an equal share of the total load presented to the power system.

In a redundant configuration, if one module fails or is otherwise not operating, the remaining module can take up the load. This allows for the hot-swapping and replacement of failed power modules while operating. When a new power module is added, the ASN-9000 immediately begins to load share between all installed power modules.

If a power module in a redundant configuration should fail, increasing the load on the remaining power module to threshold, it is important to repair or replace the failed module quickly. This is necessary not only to reinstate redundancy, but also to return the power system to a more conservative operation, further improving its reliability.

CAUTION

If only one power module is installed, ***always*** install the module in the left power module bay.

CHAPTER 5 Quickstart

This chapter provides quickstart information to assist in getting the *ForeRunner* ASN-9000 platform up and running. Detailed configuration information is not provided in this chapter. Refer to the *ForeRunner ASN-9000 Software Reference Manual* for detailed information on configuration. Some of the things discussed in this chapter include:

- Installing the chassis
- Connecting a management terminal or modem
- Booting the system
- Allocating segments
- Configuration files

5.1 Installing the Chassis

The ASN-9000 chassis is 17” deep, approximately 17” wide without the rack-mounting ears and 8 3/4” high without the rubber feet. A fully-loaded 5-slot chassis weighs approximately 100 pounds. The exact weight varies according to number of power modules and NIMs installed.

NOTE

Before proceeding with the chassis installation, go over the safety and environmental requirements discussed in *Chapter 4, Safety and Environment Requirements.*

The following sections provide procedures to mount the chassis on a tabletop or in a standard open or closed 19” equipment rack.

5.1.1 Installing the Chassis on a Tabletop

To install the chassis on a tabletop, prepare the tabletop to allow at least 3” of open space on either side and in front of the chassis, then place the chassis in the space prepared. If any NIMs or the Packet Engine were removed, replace them using the procedures outlined in Section 6.1.1 before applying power.

5.1.2 Rack Mounting the Chassis

CAUTION

When mounting the chassis in a rack, it is recommend that a metal strip or tray be installed to support the rear of the chassis. If the rear of the chassis is not supported, the chassis weight can break the bolts securing the brackets to the rack.

The system can be mounted in a standard 19” open or closed-frame rack using the supplied angle brackets. For this type of installation, the following parts and tools are needed:

- Two mounting brackets.
  The open-frame brackets are smaller than the closed-frame. Each has twelve holes for the chassis (only eight are used) and four for the rack.
- Eight screws, four for each bracket.
- A #2 Phillips-head screwdriver.
- A flat-head screwdriver.

NOTE

The Packet Engine, NIMs, and power modules should be removed from the chassis before mounting. Refer to the procedures in Section 6.1.2 and Section 6.4.

To rack mount the chassis:

1. Place the chassis on its side to access the four rubber feet on the bottom.
2. Remove the rubber feet.
3. Remove eight screws from one side of the front edge of the chassis that align with the associated screw holes in the appropriate bracket.
4. Align one of the rack-mount brackets over the screw holes. Ensure that the flange that connects to the rack is facing toward the front of the chassis. If using the open-rack brackets, when the bracket is correctly positioned, the flange is flush with the front of the chassis.
5. Insert the screws removed in step 3. Do not over-tighten the screws; they should be hand tight.
6. Repeat steps 3 through 5 for the bracket on the other side of the chassis.

7. When both brackets are installed, carefully lift the chassis into the rack, align the screw guides over the holes in the rack and insert the screws provided to attach the chassis to the rack.
8. Reinstall any modules that were removed before installing the chassis, using the appropriate procedures in Section 6.1.1 and/or Section 6.4.

NOTE

If the cable organizer is to be installed, align the cable organizer over the two empty screw holes on the right side of the front of the chassis, and insert the mounting screws into the holes.

5.2 Connecting a Management Terminal or Modem

An RS-232 cable assembly kit is included with the system. This kit contains the parts to assemble an RS-232 cable assembly. Like the RS-232 connectors on most PCs, the TTY ports are wired as DTE (Data Terminal Equipment). Refer to Figure 5.1 for an illustration of how to assemble the necessary management terminal or modem cable assembly.

NOTE

If the management terminal requires a DTE connection, a null modem or other means to swap the signal pairs in the RS-232 cable may be required.

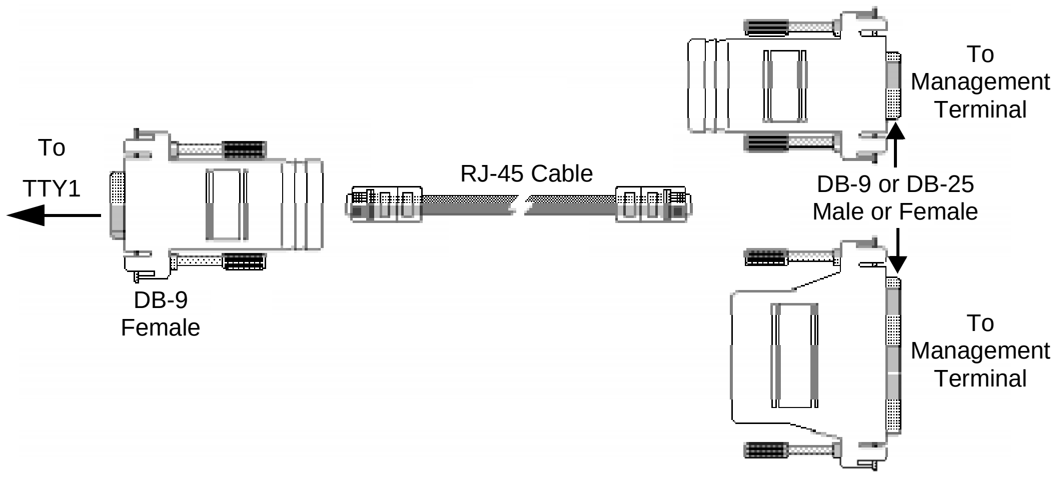

Figure 5.1 - TTY Port Cable Assembly

The initial login to the system requires that the modem or management terminal attached to TTY1 be set to 9600 baud

NOTE An additional cable is required to connect to the TTY2 port. Contact FORE Systems TAC to order an additional adapter kit for the TTY2 cable.

To connect a management terminal or modem:

1. Determine the type of connector required for the management terminal or modem side of the connection. For example, if a terminal whose serial port is a female DB-9, a male DB-9 connector is needed. If a DB-25, a male DB-25 connector is needed. If the management terminal or modem port is wired as DTE, use a null modem or some other means to swap the signal pairs in the RS-232 cable as indicated in Figure 5.2.

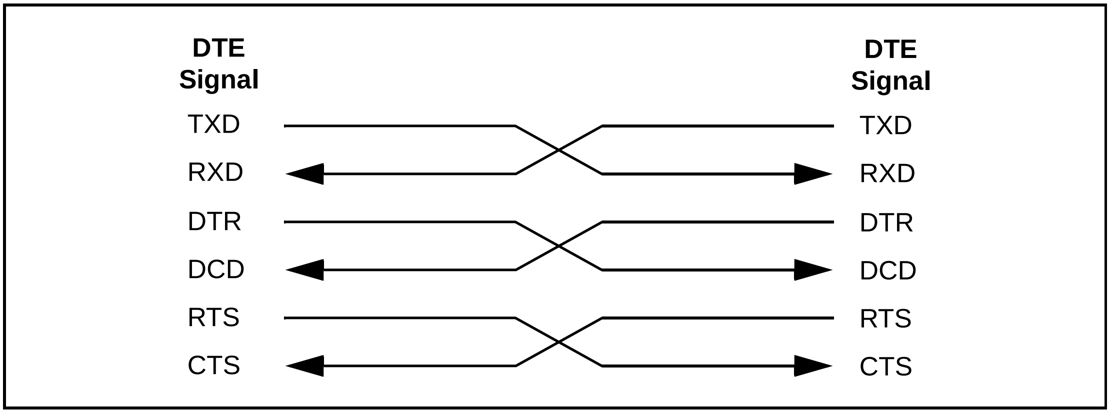

Figure 5.2 - DTE Null Modem Connections

2. Select the RJ-45 cable and DB-9 or DB-25 connector shell that fits the terminal or modem port from the kit.
3. Using Table 5.1, assemble the appropriate connector. For example, if a DB-9 connection to a PC DTE is needed, and a null-modem function is to be incorporated in the cable, use the DB-9 column on the Modem Signal (DCE) side of Table 5.1.
4. Set the serial port on the modem or management terminal to 9600 baud.
5. Plug the RJ-45 connector into the management terminal or modem connector just assembled.
6. Plug the management terminal or modem connector into the management terminal or modem.

Table 5.1 - RS-232 (TTY) Pinout Reference

RJ-45*	**Terminal (DTE)**	**DB-25**	**DB-9**	**Modem (DCE)**	**DB-25**	**DB-9**
6 (Yellow)	TXD	3	2	TXD	2	3
3 (Black)	RXD	2	3	RXD	3	2
4 (Red)	GND	7	5	GND	7	5
7 (Brown)	DTR	6	6	DTR	20	4
5 (Green)	DCD	20	4	DCD	8	1
8 (White)	RTS	5	8	RTS	4	7
1 (Blue)	CTS	4	7	CTS	5	8
2 (Orange)	n/a	n/a	n/a	DSR	6	6

* The colors refer to the wires inside the connector shells, not the wires in the cable itself.

5.3 Booting the System

This section discusses the four different methods of booting the ASN-9000 software. The software can be loaded by:

- Turning on the power supplies.
- Pressing the Reset Switch (RST) on the Packet Engine.
- Issuing the **`boot|b`** command from a boot PROM (`<7PE>`) prompt.
- Issuing the **`reboot`** command from the system (`ASN-9000:system#`) prompt.

CAUTION

Ensure that the chassis contains at least the minimum number of power modules to support the configuration. Refer to Section 4.8 for instructions on how to determine if sufficient power is available to support the installed configuration. Also, make sure a power module is installed in the primary (upper-left) power module bay.

The first two options are physically performed by either turning the power modules on or pressing the reset (RST) switch on the Packet Engine (PE). To power on the ASN-9000:

1. Ensure that all unused slots and bays in the chassis are covered with the proper cover plates. Operating the ASN-9000 without cover plates installed over unused bays or slots is unsafe, potentially damaging, and can void the warranty.
2. Plug the power module cables into the power modules, then into a grounded circuit(s) capable of supplying the required amount of AC or DC current.
3. Switch on all power modules at the same time (or at least the minimum number of modules required for the configuration). If at least the minimum number of power modules required are not powered on, the power modules powered on may become overloaded and shut down. To simplify this step, plug all of the power modules into a power strip or into the same circuit, then apply power to the strip or circuit to simultaneously apply power to all modules.

NOTE

If a power module becomes overloaded and shuts down, switch all the power modules off to reset the ones that are overloaded, then simultaneously switch all the power modules on again.

When enough power modules are powered on to meet the configuration's power needs, the Packet Engine boots and conducts a power-on self-test. When the Packet Engine boots, the Boot (B) LED flashes to indicate that the module is booting. As soon as the Packet Engine finishes booting, the Boot LED becomes dark and one of the Status (S) LEDs on the left end of the Packet Engine glows steadily, indicating that the ASN-9000 is ready for operation.

Messages, similar to the following, are displayed on the management terminal during the boot process.

```
FORE Systems PowerHub 7000 Packet Engine
Prom version: 7pep-2.5.7 (s1.89) 1997.09.24 14:30
I-cache 16KB OK
Entering cached code
I-cache execution OK
D-cache 4KB OK
SRAM 128KB OKDRAM 24MB OK
Shared Memory 4MB OK
Entering Monitor
FlashInit: found 2MB Flash Memory Module
Board Type: 7PE ,  CpuType: MCPU,  Instance: 1
Ethernet address: 00-00-ef-03-9a-b0
(normal start)
Hit any key now to abort boot [4]:
```

If the ASN-9000 does not boot when power is applied, check the LEDs on the power modules and Packet Engine. If no LEDs are glowing, there may be an overload in the power circuit or the ASN-9000 may not have sufficient power to support the configuration. First ensure that there are sufficient power modules for the configuration, then check the power circuit. For information on power requirements for different configurations, refer to Section 4.8.

When the system completes loading the software, a system runtime command prompt is displayed. However, if the boot process is aborted, the prompt for the Packet Engine boot PROM (`<7pe>`) is displayed.

To load the system software from the Boot PROM (`<7pe>`) prompt, issue the **`boot|b`** command. The syntax for this command is:

`b [net|fm]`

where:

net
Boot from the network. (The ASN-9000 is an ATM only system and, therefore, netbooting is not implemented.)

fm
Boot from the Flash Memory Module.

NOTE

If a boot source is not specified, the boot order configured in NVRAM is used. If a boot order has not been configured, the system attempts to boot first from the Flash Memory Module, then the floppy disk.

5.3.1 Specifying the Boot Source

The ASN-9000 can be configured to load the software from the Flash Memory Module or floppy disk. The ASN-9000 can be configured to use one method exclusively, or to try one method first, then try one or both of the other methods.

NOTE

If the ASN-9000 boots from the Flash Memory module or floppy disk, no connection to the network is required.

To specify the boot source:

1. If not already done so, power on the ASN-9000. A PowerHub#system command prompt is displayed.
2. Enter the following command at the nvram subsystem prompt or the Boot PROM command prompt, then press Enter:

`bo set <value>`

where <value> specifies the boot source(s). The available boot sources are:

f - floppy disk
m - flash Module
n - network (bootp / tftp)

NOTE The ASN-9000 is an ATM only system, therefore, netbooting is not implemented.

5.4 Allocating Segments

When shipped from the factory, the ASN-9000 is configured to recognize six independent segments per NIM slot in the chassis. This means that if the chassis contains any modules that have more than six segments, the software recognizes only the first six segments of the module

In addition to recognizing only the first six segments, the software numbers the segments in the chassis based on six segments per NIM slot.

If the ASN-9000 chassis does not contain any modules with more than six segments on a module, the default segment allocations (six per NIM slot) work for this system. The software counts six segments per slot, but all segments on the modules are recognized.

However, if the chassis contains modules that have more than six segments, segments to the NIM slots must be explicitly allocated.

To allocate segments for a NIM slot, issue the following command from the runtime or the <PROM-7PE> command prompt:

```
slotsegs[<n>] set <segment-count>
```

where:

[<*n*>] Specifies the NIM slot number (the brackets [ ] are required).

<segment-count> Specifies how many segments to allocate for the module in slot[n]. Enter the number appropriate for the module installed. ASN-9000 ATM modules support a maximum of 32 segments per module.

Repeat this command for each NIM slot in the chassis.

NOTE Segments may be allocated only for NIM slots that contain modules with more than six segments. However, it is recommended that segments for all NIM slots be explicitly allocated, to eliminate “empty” segments.

The segment allocations are stored in NVRAM on the Packet Engine. If the Packet Engine is changed for any reason, the segments need to be re-allocated and the values stored in NVRAM of the new Packet Engine.

5.4.1 Verifying Segment Allocations

To display the segments allocated to a particular NIM slot, issue the following command:

```
slotsegs[<n>] [show]
```

where:

[<n>] Specifies the NIM slot number (the brackets [ ] are required). This argument is optional. If the slot number is not specified, segment allocations for all slots (1-20) are displayed.

5.4.2 Attaching Network Segments

To attach network segments to the ASN-9000, simply plug the segment cables into the appropriate segment connectors.

5.4.3 Enabling Automatic Segment-State Detection

Automatic-segment state detection enables the software to note changes in the state of segments (whether they go up or come down). This software automatically enables bridging and routing on segments that are active and marks the changes in corresponding table displays. (See *ForeRunner ASN-9000 Software Reference Manual* for more information about Automatic segment-state detection.

5.5 Configuration Files

When the ASN-9000 boots, the software looks for a configuration file (`cfg`) on the device specified as the boot source (default-device). When the configuration file is read, the configuration changes saved in the file are reinstated on the ASN-9000. The configuration file name is specified in the boot definition file (`bootdef`), if used. If no bootdef file is used the system uses a '`virtual bootdef`' and assumes the default-device contains the cfg file. If no cfg file is present on the default-device, no configuration information, other than the currently installed components are read. Multiple configuration files, named other than `cfg`, can be maintained on the default-device. Refer to the *ForeRunner ASN-9000 Software Reference Manual* for more information on the **savecfg** and **readcfg** commands.

NOTE

If more than one boot source is to be used, it is recommended that the same configuration be saved to each boot source. These procedures are described below. To avoid potential problems, ensure that the configuration files on all boot sources match.

5.5.1 Saving the Configuration

Configuration files can be saved to Flash Memory or floppy disk to allow for faster booting. To save the current configuration, issue the **`savecfg|svcfg`** command from the `system` subsystem. The syntax of this command is:

```
savecfg|svcfg <file or device name>
```

A filename for the saved configuration file must be specified. The default filename is `cfg`. If the file is to be saved to other than the default-device, the address of the other device must be specified (`fm:` or `fd:`).

5.5.2 Reading a Configuration

To read a configuration file, issue the **`readcfg|rdcfg`** command from the `system` subsystem, specifying the name of the unique configuration file and the device it resides on (`fm:` or `fd:`), if other than the default-device. The syntax of this command is:

```
readcfg|rdcfg [-v] <file or device name>
```

where

-v Specifies that each line of the configuration file is to be displayed to the console when executed.

CHAPTER 6 Installation and Removal Procedures

This chapter provides procedures for installing and removing major components of the ASN-9000. The major components of an ASN-9000 covered in this chapter include:

- Packet Engine and Network Interface Modules (NIMs) (Section 6.1)
- Flash Memory Module (Section 6.2.1)
- Packet Accelerator (Section 6.2.2)
- ATM Media Adapters (Section 6.2.3)
- Changing the Lock Switch Jumper (Section 6.2.4)
- Fan Module (Section 6.3)
- Power Module (Section 6.4)

For detailed information on major components of the ASN-9000 refer to the appropriate section of this manual. The related chapters are:

- Chassis and Packet Engine (*Chapter 2, Chassis and Packet Engine*)
- ATM Interfaces (*Chapter 3, ATM Interfaces*)

6.1 Packet Engine and NIMs

The following sections provide procedures on the installation and removal of the Packet Engine and NIMs. The tools required for these procedures are:

- ESD wrist strap
- Medium flat-blade screwdriver
- #2 Phillips screwdriver
- Grounded work surface, such as a grounded metal table or a table covered with a grounded, rubberized mat.

6.1.1 Installing a Packet Engine or NIM

CAUTION

Static electricity can damage the electronic components of the ASN-9000. Refer to *Chapter 4, Safety and Environment Requirements,* for the appropriate precautions to be taken when handling ASN-9000 components.

1. If the slot the module is to be installed in is not covered with a cover plate, go to step 2. If the slot has a cover plate, remove the two screws securing the cover.

WARNING!

Power must be removed from the system before installing or removing a Packet Engine.

NOTE

If installing a NIM in an empty slot, or installing a NIM that is of a different type than the one currently installed, power off the ASN-9000 before the installing the NIM.

2. If installing a module in an empty slot, go to the step 3. If the slot is not empty, remove the module from the slot before installing. Refer to Section 6.1.2 for procedures to remove a module.
3. Holding the module by its plated edges, align the rear corners of the module in the grooves on either side of the slot. The groove is just below the screw holes for the thumbscrews, as shown in Figure 6.1.

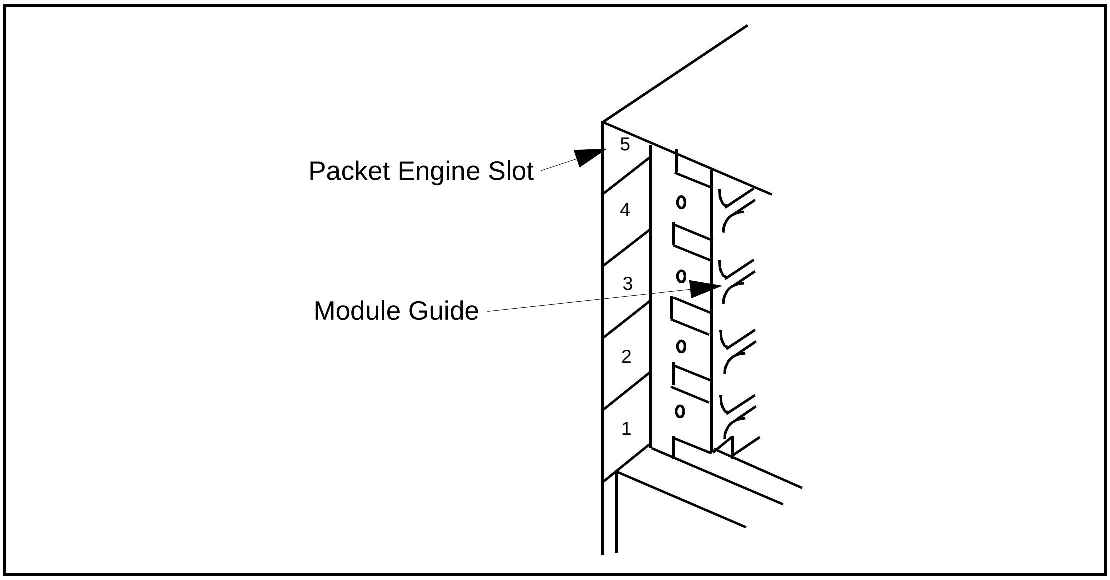

Figure 6.1 - Module Card Guides

CAUTION

Do not touch the components on the module. The Packet Engine installs in slot 5 in a 10-slot chassis and slot 10 in a 15-slot chassis.

4. Slide the module at least two-thirds of the way into the slot. Do not force the module. If it does not slide easily, remove it and try again.
5. Grasp the ejector handles on each end of the module, making sure the handles point back away from the chassis, and push the module the rest of the way into the slot. When the module is in place, the front panel is flush with the other modules or cover plates in the chassis.

CAUTION

Each module has an activation switch, located behind the ejector handle on the left side of the module. For the module to operate, the ejector handle must be pressing on the activation switch. When installing the module, make sure the ejector handles are pressed all the way into place.

6. Secure the module in place by pressing the ejector handles against the front panel.
7. Use the flat-head screwdriver to tighten the thumbscrews.

CAUTION

The thumbscrews must be tightened to prevent the module from coming loose from the chassis through ordinary vibration. If the module becomes loose, the activation switch is disengaged. When this happens, the module automatically shuts down.

8. If the **`card-swap disable`** command was used to remove a NIM from this slot and the same type of NIM is being installed, use the **`card-swap enable`** command from the **`system`** runtime command prompt to notify the system that the NIM has been replaced.

    `enable card-swap|cs` *<slot>*

    where: *<slot>* is the number of the slot in which the NIM is installed.

9. Attach / reattach network segments to the NIMs or the management terminal to the Packet Engine.

6.1.2 Removing a Packet Engine or NIM

CAUTION

Static electricity can damage the electronic components of the ASN-9000. Refer to *Chapter 4, Safety and Environment Requirements*, for the appropriate precautions to be taken when handling ASN-9000 components.

1. Disconnect all management and / or network cables from the module being removed.

2. Perform one of the following:
   - If removing a Packet Engine, power off the ASN-9000.
   - If removing a NIM and replacing it with a NIM of a different type, power off the ASN-9000.
   - If removing a NIM, and replacing it with a NIM of the same type issue the **card-swap** command from the **system** subsystem.

   card-swap disable *<slot>*

   where: *<slot>* is the number of the slot in which the NIM is installed.

3. Loosen the two thumbscrews securing the module in the chassis.
4. Lift the ejector handles by carefully pulling them away from the module.
5. Grasp the ejector handles and pull the module out until it is about one half of the way out of the chassis.
6. Holding the module by its plated edges, remove it from the chassis and set it on a grounded work surface or anti-static bag.

6.2 Packet Engine (PE)

The Packet Engine (PE) contains several components that can be replaced. Replacement of these components could be the result of a failure of a component or to upgrade the component. The components include:

- Flash Memory Module
- Packet Accelerator

The following paragraphs provide procedures for the installation and/or removal of these components. Refer to Figure 6.2 for physical locations of these components when performing these procedures.

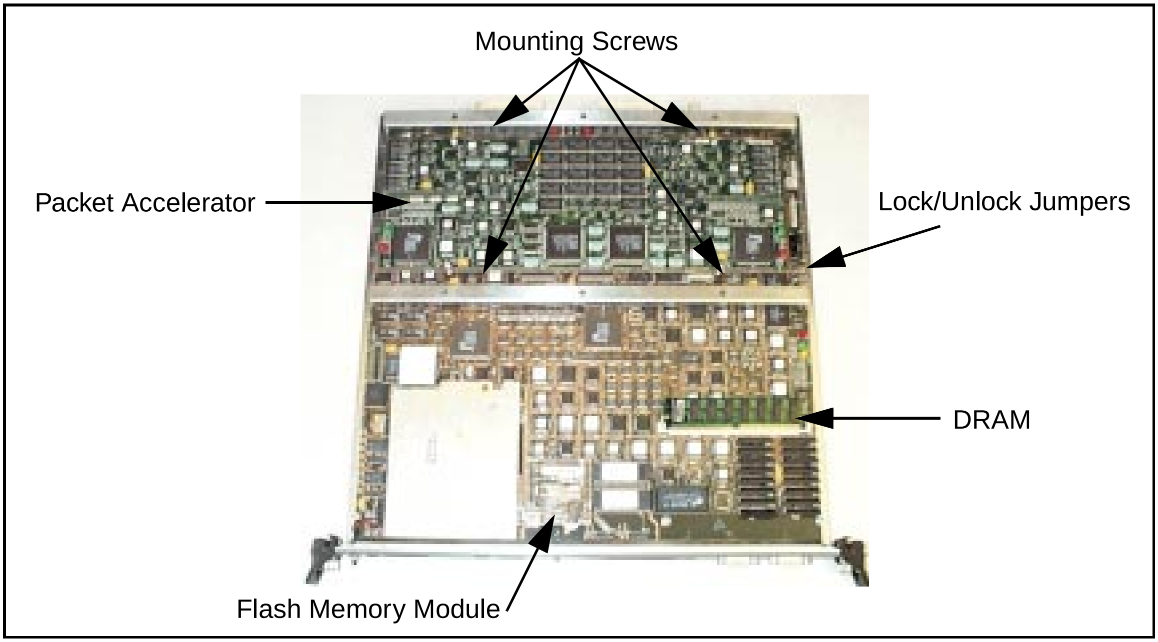

Figure 6.2 - Packet Engine (PE)

6.2.1 Installing and Removing Flash Memory

The following procedures should be used to install or remove the Flash Memory Module on a Packet Engine (PE). A #2 Phillips screwdriver is the only tool required to perform this procedure. Figure 6.2 shows the location of the Flash Memory Module and the screw that secures it to the PE. Refer to this figure while performing this procedure.

6.2.1.1 Installing a Flash Memory Module

CAUTION

Static electricity can damage the electronic components of the ASN-9000. Refer to *Chapter 4, Safety and Environment Requirements*, for the appropriate precautions to be taken when handling ASN-9000 components.

1. Follow the procedure in Section 6.1.2 to remove the PE from the chassis.

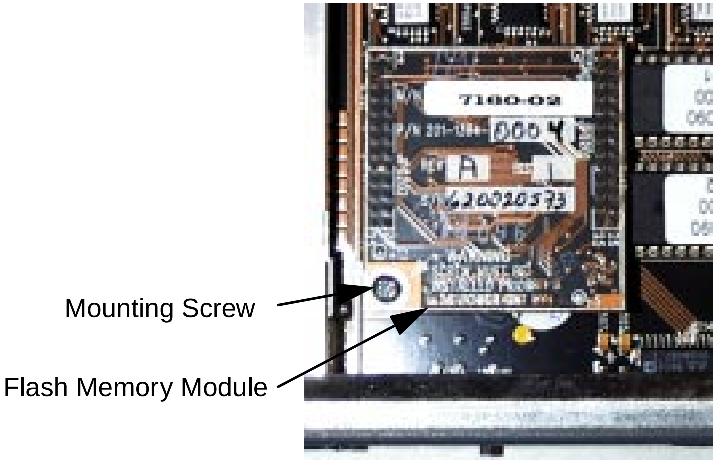

Figure 6.3 - Flash Memory Module

2. Remove the Flash Memory Module from its protective packaging. It is oriented correctly when the stand-off on the PE can be sighted through the corresponding hole in the module.
3. Gently press down on the module when the headers are properly aligned over the pins on the PE.
4. When the module is completely seated on the pins, insert the supplied screw into the stand-off from the underside of the module and tighten.
5. Install the PE into the chassis following the procedure in Section 6.1.1.
6. When the PE and any other removed NIMs have been installed, power on the unit and watch the boot messages for a line similar to the one shown in Figure 8.x in bold type. If this line is present and shows the correct amount of Flash Memory that was installed, the installation was successful. Try issuing some of the file management commands, see the *ForeRunner ASN-9000 Software Reference Manual, System Commands.*

NOTE

If file management commands consistently return an error message, such as, <*command*>: -65, where <*command*> is the command attempted, it is necessary to format the Flash Memory module. To format the module, issue the **`format fm:`** command (Refer to the *ForeRunner ASN-9000 Software Reference Manual* for detailed information on the **`format`** command).

6.2.1.2 Removing a Flash Memory Module

CAUTION

Static electricity can damage the electronic components of the ASN-9000. Refer to *Chapter 4, Safety and Environment Requirements*, for the appropriate precautions to be taken when handling ASN-9000 components.

1. Follow the procedure in Section 6.1.2 to remove the PE from the chassis.
2. Remove the mounting screw securing the Flash Memory Module to the PE as shown in Figure 6.3.
3. Gently pull up on the Flash Memory Module to free the pin headers from the pin sockets on the PE. If the module does not lift freely, gently rock it from side-to-side to loosen the pins.
4. Place the module in its protective packaging.
5. If not reinstalling a Flash Memory Module, follow the procedure in Section 6.1.1 to reinstall the PE.

6.2.2 Removing and Installing a Packet Accelerator

CAUTION

Static electricity can damage the electronic components of the ASN-9000. Refer to *Chapter 4, Safety and Environment Requirements*, for the appropriate precautions to be taken when handling ASN-9000 components.

The following procedures describe how to install or remove the Packet Accelerator on a Packet Engine. A #2 Phillips screwdriver is the only tool required to perform this procedure. Figure 6.2 shows the location of the Packet Accelerator and the screws that secure it to the PE. Refer to this figure while performing this procedure.

6.2.2.1 Installing the Packet Accelerator

The following procedure describes how to install a Packet Accelerator onto the PE. Refer to Figure 6.2 for the location of the Packet Accelerator and the screws securing it to the PE.

1. Follow the procedure in Section 6.1.2 to remove the PE from the chassis.
2. Remove the Packet Accelerator from its protective packaging. It is oriented correctly when the stand-off on the PE can be sighted through the corresponding hole in the module.
3. Gently press down on the Packet Accelerator when the headers are properly aligned over the pins on the PE.
4. When the Packet Accelerator is completely seated on the pins, insert the supplied screws into the stand-offs and tighten.
5. Install the PE into the chassis following the procedure in Section 6.1.1.
6. When the PE and any other removed NIMs have been installed, power on the unit and watch the boot messages for a line similar to the one shown in bold type. If this line is present and shows the Packet Accelerator was installed, the installation was successful.

```
Looking for packet accelerator card
1 2
Found packet accelerator - will use 4MB shared memory
Packet accelerator IOPs will be used
```

6.2.2.2 Removing the Packet Accelerator

The following procedure describes how to remove a Packet Accelerator from the PE. Refer to Figure 6.2 for the location of the Packet Accelerator and the screws securing it to the PE.

1. Follow the procedure in Section 6.1.2 to remove the PE from the chassis.
2. Remove the mounting screws securing the Packet Accelerator to the PE as shown in Figure 6.2.
3. Gently pull up on the Packet Accelerator to free the pin headers from the pin sockets on the PE. If the module does not lift freely, gently rock it from side-to-side to loosen the pins.
4. Place the Packet Accelerator in its protective packaging.
5. If not reinstalling a Packet Accelerator, follow the procedure in Section 6.1.1 to reinstall the PE.

6.2.3 ATM Media Adapters

This section provides procedures to install or remove ATM media adapters (AMAs) supported by the ASN-9000 PowerCell ATM Module. The ASN-9000 supports the following ATM Media Adapters.

Table 6.1 - ATM Media Adapters

ASN-9000 PowerCell ATM Media Adapters	
	OC-3 (single- or multimode)
	DS-3
	UTP

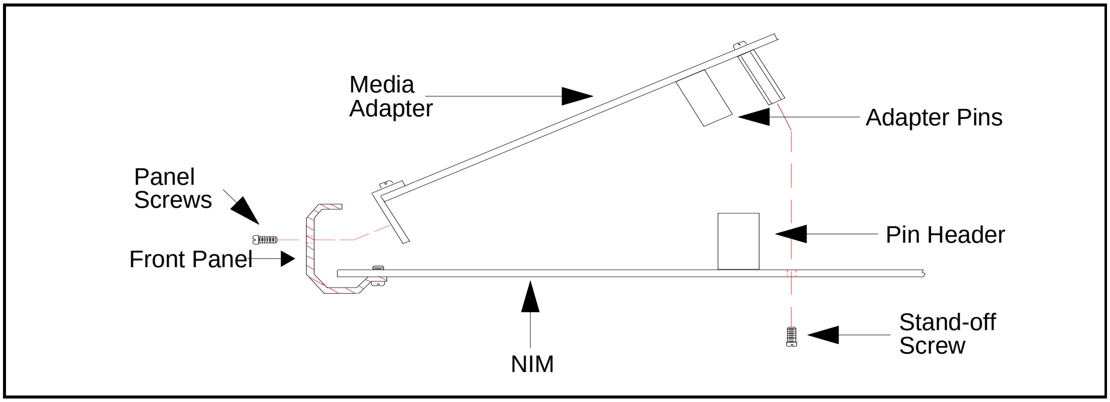

Figure 6.4 - Removing/Installing a Media Adapter

6.2.3.1 Installing a Media Adapter

CAUTION

Static electricity can damage the electronic components of the ASN-9000. Refer to *Chapter 4, Safety and Environment Requirements*, for the appropriate precautions to be taken when handling ASN-9000 components.

The following procedure describes how to install a media adapter on a ASN-9000 NIM. The pin sockets on some NIMs contain a plastic border around the pins. This border creates a tight fit for the media adapters when installing them. The following tools are required to install a media adapter:

- #2 Phillips screwdriver
- Medium flat-head screwdriver
- 3/16” hex nutdriver
- A grounded work surface, such as a grounded metal table or a table covered with a grounded, rubberized mat is required if components are to be removed or installed.

1. Remove the two screws securing the blank faceplate covering the empty adapter bay to the front of the NIM. Retain the blank faceplate and screws in the event the adapter is later removed.
2. While holding the rear of the adapter, gently insert the segment/port connector of the adapter through the opening on the NIM front panel as shown in Figure 6.4. Notice that adapter is installed component-side down.
3. Ensure that the segment/port connector is fully forward by pushing on it until it is firmly in place. The front of the adapter must be flush with the back of the front panel.
4. Align the adapter pins directly over the pin socket on the NIM.

CAUTION

Visually ensure that the standoffs and their corresponding screw holes, and the connector pins and their corresponding pin sockets are properly aligned. If the pins and sockets are not aligned properly, the pins can break and the NIM and/or adapter can be damaged.

5. When the pins are properly aligned over the socket, firmly and evenly press the backside of the adapter down to push the pins into the socket. While pushing down on the adapter, it may be necessary to gently rock it side-to-side to help seat the pins into the socket.

CAUTION

When seating the adapter, check the sides of the pin socket for pins that are protruding. If increased resistance is felt when seating the adapter, or if pins are protruding from the side of the pin socket, stop seating the adapter, and remove it.

Repeat step 5 to attempt to seat the adapter. If the module still does not seat properly, call the FORE Systems TAC.

When the adapter is properly seated, it should appear as shown in Figure 6.5.

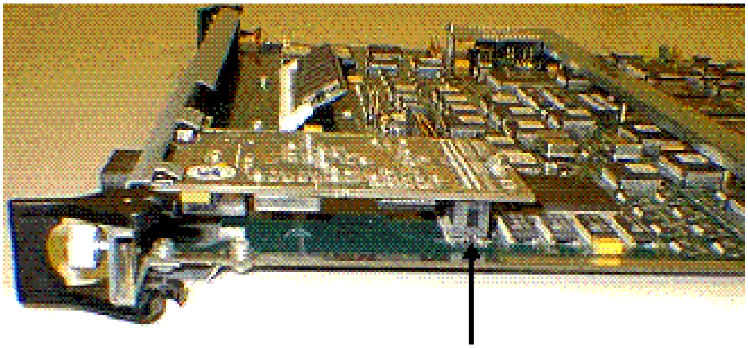

Figure 6.5 - Media Adapter Alignment

6. To secure the adapter to the NIM, insert and tighten the screw on the underside of the NIM.

NOTE

If installing a FMA, insert and tighten the other supplied screw through the screw hole on the adapter into the top of the standoff. Remember that adapters are installed component-side down.

CAUTION

Be sure to use the screws provided with the adapter. Use of screws other than those provided may result in damage to the adapter or the NIM.

7. Re- insert the NIM into the ASN-9000, securing the thumbscrews.
8. If no more adapters are to be removed from this NIM, use the procedure in Section 6.1.1 to reinstall the NIM.
9. Reboot the system to activate the changed system configuration.

6.2.3.2 Removing a Media Adapter

CAUTION

Static electricity can damage the electronic components of the ASN-9000. Refer to *Chapter 4, Safety and Environment Requirements,* for the appropriate precautions to be taken when handling ASN-9000 components.

The following procedure describes how to remove a media adapter from a ASN-9000 NIM. The pin sockets on some NIMs contain a plastic border around the pins. This border creates a tight fit for the media adapters when removing them. The following tools are required to remove a media adapter:

- #2 Phillips screwdriver
- Medium flat-head screwdriver
- 3/16” hex nutdriver
- Regular flat-head screwdriver
- ESD wrist-strap
- A grounded work surface, such as a grounded metal table or a table covered with a grounded, rubberized mat is required if components are to be removed or installed.
- If the removed Media Adapter is not to be replaced, the appropriate cover plate.

Figure 6.4 shows how a Media Adapter is removed from a module.

1. Use the procedures in Section 6.1.2 to remove the NIM containing the media adapter to be removed from the chassis.

CAUTION

Never attempt to add, remove, or modify components on a Packet Engine or NIM when the module is still in the chassis. Components can become broken or damaged through electrostatic discharge, or the module itself can become cracked through improper handling.

2. Remove the screw and washer securing the adapter to the NIM. These are located on the underside of the NIM. Do not remove the standoff on the adapter itself.
3. Remove the two pan-head screws securing the adapter to the NIM front panel.
4. Grasp the rear of the adapter, making sure not to grab the pin connections. (These can become bent and damage the adapter.)
5. Gently pull up on the rear of the adapter to loosen the pins from the socket on the NIM. If the pins do not come loose, gently rock the rear of the adapter from side to side while pulling up. Stop pulling as soon as the pins come loose to prevent damaging the adapter.
6. When the adapter pins are free from the socket on the NIM, gently pull the adapter straight out of the NIM front panel. If the adapter gets caught, gently jiggle it free. Do not force the adapter to come free to prevent damaging components.
7. When the adapter is completely free of the NIM, either place it in its protective container for storage or, if planning on installing it in another NIM, place it on a grounded table.
8. If the adapter is not to be replaced with another adapter, install the appropriate cover plate over the unused adapter position.
9. If no more adapters are to be removed from this NIM, use the procedure in Section 6.1.1 to reinstall the NIM.
10. Reboot the system to activate the changed system configuration.

6.2.4 Changing the Setting of the Lock Switch Jumper

The PE has two hardware mechanisms to restrict access to the ASN-9000; the Lock/Unlock Switch and Lock/Unlock Jumpers.

Both the Lock/Unlock Switch and the Lock/Unlock Jumpers are located on the PE. The Lock/Unlock Switch is located on the front panel and the Lock/Unlock Jumpers are located on the circuit board itself. The Lock/Unlock Jumpers are inaccessible without removing the PE from the chassis.

When the Lock/Unlock Switch is set on (L) a userid and password are required to access the ASN-9000. When set to off (U), no userid or password is required and anyone can access the ASN-9000 through the TTY1/TTY2 ports or a Telnet session.

The Lock/Unlock Jumper has LOCK, and UNLOCK jumper positions to override either position of the switch. A third position SPARE can be used as a storage position for the jumper when the Lock/Unlock Switch is used to control access to the ASN-9000. If the jumper is set to Lock, or Unlock, changing the position of the Lock/Unlock Switch has no effect on the operation of the ASN-9000.

The following procedure describes how to set the Lock/Unlock Jumper. Refer to Figure 6.2 for the location of the Lock/Unlock Jumpers on the PE.

CAUTION

Never attempt to add, remove or modify components on a P E or NIM when the module is installed in the chassis. Components can become broken or damaged through electrostatic discharge, or the module itself can become cracked through improper handling.

1. Follow the procedure in Section 6.1.2 to remove the PE from the chassis.
2. Locate the Lock/Unlock Jumpers. Figure 6.6 shows a close-up of the Lock/unlock Jumpers on the PE.

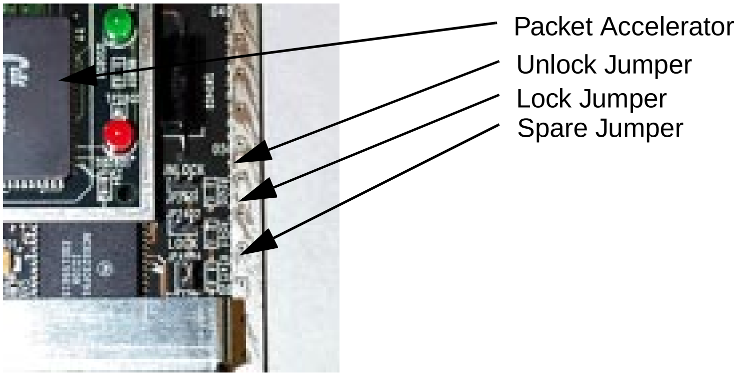

Figure 6.6 - PE Lock/Unlock Jumpers

3. To set the Lock Switch Jumper, disabling the front panel Lock / Unlock Switch forcing restricted access to the ASN-9000, remove the jumper from the UNLOCK or SPARE pin headers and place it across the LOCK pin headers.
4. To set the Unlock Switch Jumper, disabling the front panel Lock / Unlock Switch allowing unrestricted access to the ASN-9000, remove the jumper from the LOCK or SPARE pin headers and place it across the UNLOCK pin headers.
5. To disable the Lock / Unlock Switch Jumper, enabling the front panel Lock / Unlock Switch, remove the jumper from the UNLOCK or LOCK pin headers and place it across the SPARE pin headers.

6.3 Replacing a Fan Module

The fan module is designed for easy installation or removal. In case of failure, the entire fan module can quickly and easily be replaced.

NOTE

Never operate the ASN-9000 without a fan module installed. This may cause the ASN-9000 to overheat and any resulting damage is not covered by warranty.

WARNING!

Never attempt to change a fan module with power applied to the chassis. The procedure calls for removing the back panel. Inside the back panel are the power busses for the chassis.

To replace a failed fan module, the following tools are required:

- A #2 Phillips-head screwdriver.
- A regular flat-head screwdriver.

To replace a failed fan module:

1. Remove all power from the ASN-9000.
2. Remove the phillips screws located around the perimeter of the back panel.
3. Gently pry the top edge of the rear panel away from the chassis. Be careful not to scratch the chassis.

4. When the top of the rear panel is free from the chassis, gently pull the rear panel down and away from the chassis. Be careful not to bend the flange on the bottom of the panel. The rear panel is designed to rest horizontally, held in place by this flange.
5. Remove the two phillips screws securing the failed fan module.
6. Unplug the connector of the failed fan module from the Packet Channel backplane. The connector could be labeled “FAN” or “JF1”.

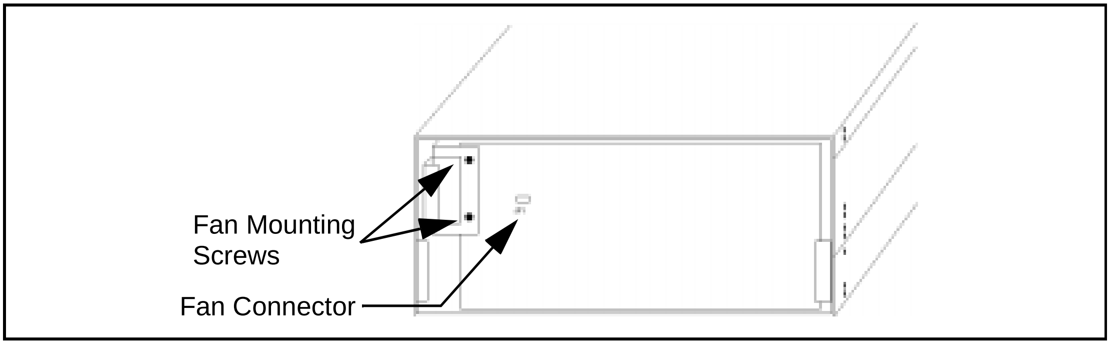

Figure 6.7 - Location of Fan Module Connectors

7. Grasp the fan module by the handle and pull it all the way out of the chassis. If the fan module sticks, jiggle it gently to free it, then continue pulling.
8. Insert the replacement fan module.
9. Plug the connector of the replacement fan module onto the appropriate pin(s) (marked “FAN” or “JF1”). The connector is keyed and can only be installed one way.
10. Replace the two screws securing the fan module to the chassis.

NOTE

If the ASN-9000 is operating during this procedure, the new fan module begins to operate as soon as the connector is plugged in.

11. Put the back panel back into place, taking care not to bend the flange on the bottom of the panel.
12. Replace the screws securing the back panel to the chassis.
13. Reapply power to the ASN-9000.

6.4 Replacing a Power Module

Power modules can be installed during operation if redundant power modules are installed. If only one power module is installed, ***always*** install the power module in the left power module bay. The only tools required to replace a power module is a #2 Phillips-head screwdriver.

To replace a failed power module:

1. Turn the power switch to the OFF position (marked **O**).
2. Loosen the two thumbscrews on the power module to be replaced. The thumbscrews should disengage from the chassis, but not from the power module.
3. Gently pull the power module from the power module bay, keeping the power supply level to avoid damaging any NIMs in the slot above the power supply bay.

NOTE

If a new power module is being installed in a power module bay that is currently empty and is covered by a protective cover plate, remove the two screws from the cover plate. Remove the cover plate. Do not place the plate or screws inside the power module bay.

4. Place the rear of the power module into the empty power-module bay, keeping the power module level. Tilting the power module upward may contact the NIM in the slot above it and damage the NIM.
5. Gently slide the power module all the way into the bay. Do not force the power module into place. If it does not slide easily into place, remove it and try again.
6. When the power module is fully in place and firmly tighten the thumbscrews.
7. Plug the power cable into the receptacle on the front of the power module.
8. Plug the other end of the cable into the appropriate 110-volt or 220-volt AC circuit or 40 – 60-volt DC power source. If installing a DC power module, connect the cable to the power source as follows:
   - Black wires -48-volt.
   - Red wires +48-volt.
   - Green wires Ground.

WARNING!

For the DC power module, connect the wires as described above. If the wires are connected differently and power is applied, the power module and the ASN-9000 might be damaged. Damage caused by incorrect wiring is not covered by warranty.

9. Turn the power switch to the ON position (marked |).

Provided a “load” is present in the chassis (at least a Packet Engine), the power module begins supplying current as soon as the power switch is turned on. (The power module does not activate if no load is present.) All three LEDs on the power module’s front panel light up. If any of these LEDs fails to light up, check the power connections and try again. If the problem persists, contact FORE Systems TAC.

CHAPTER 7 Boot PROM Commands

The ASN-9000 supports boot PROM commands which can be used to manage and store files, view the configured Ethernet address, set or unset nvram boot order variables and boot the ASN-9000 from either the default device or to designate a different boot source. The boot PROM prompt is not accessible during normal runtime operation, but is displayed if the boot process is interrupted or if an error occurs during the boot sequence. The boot PROM command prompt is displayed as <PROM-7pe>. Boot PROM commands can be used to perform the following tasks:

- Boot the ASN-9000
- Copy files
- Display the MAC (Ethernet) address
- Display a list of Boot PROM commands
- Display files using familiar DOS / UNIX directory commands
- Specify a console display limit
- Specify a boot order
- Remove or rename files
- Send or receive files using zmodem protocols

7.1 Booting the System Software

ASN-9000 software can be loaded using any of the following methods:

NOTE Configuration changes made since the last time the ASN-9000 software was loaded should be saved using the **`system savecfg`** command before performing a cold reboot. For information on the **`savecfg`** command, refer to *ForeRunner ASN-9000 Software Reference Manual.*

- Pressing the reset switch (labeled RST), on the front of the Packet Engine.
- Turning off, then on, the power supplies.
- Issuing the **`system reboot`** command from any system level command prompt.
- Issuing the **`boot`** command from the boot PROM command prompt.

For detailed information on the ASN-9000 software systems, refer to the *ForeRunner ASN-9000 Software Reference Manual.*

7.1.1 Displaying the Packet Engine Boot PROM

When rebooting or resetting the ASN-9000, a power-on self-test is performed before the software is loaded. When the power-on self-test is complete, and before the software is loaded, the following message is displayed:

```
Hit any key now to abort boot [3]:
```

The ASN-9000 counts down for five seconds before it resumes the boot sequence. The ASN-9000 attempts to boot from the boot sources in the order specified by the **`nvram bo`** command. If no boot order was set, the ASN-9000 attempts to boot in the order specified in Section 7.2.1. If a key is pressed during the countdown, the ASN-9000 aborts the boot sequence and the boot PROM prompt is re-displayed.

7.1.2 Reset Switch

The reset switch is located on the Packet Engine front panel and is labeled RST. When the reset switch is pressed, the Packet Engine performs a “cold” restart. During a cold restart, a power-on self-test of the Packet Engine is conducted to check its various hardware components.

Depending on the boot preference(s) specified with the nvram command, the Packet Engine loads the appropriate files that are located in default-device, or on a TFTP server (network booting) to configure the ASN-9000 for runtime operation.

7.1.3 Turning the Power Modules Off and On

Turning the power modules off and then on again, also causes the ASN-9000 to perform a cold restart.

NOTE If there is more than one power module installed in the chassis, turn all power modules off and then on, simultaneously.

7.1.4 Using the Reboot Command

To reboot the ASN-9000 from a runtime command prompt, issue the **`reboot`** command from the **`system`** subsystem or enter **`system reboot`** from within any subsystem. Entering **reboot** displays the following messages on the console:

```
66:ASN9000:system# reboot

FORE Systems PowerHub 7000 Packet Engine
Prom version: 7pep-2.5.7 (s1.89) 1997.09.24 14:30
I-cache 16KB OK
Entering cached code
I-cache execution OK
D-cache 4KB OK
SRAM 128KB OK
DRAM 24MB OK
Shared Memory 4MB OK
Entering Monitor
FlashInit: found 4MB Flash Memory Module
Board Type: 7PE ,  CpuType: MCPU,  Instance: 1
Ethernet address: 00-00-ef-03-9a-b0
(normal start)
Hit any key now to abort boot [5]:
<PROM-7PE>
```

7.2 Boot PROM Commands

The following sections explain the Boot PROM commands. The Boot PROM commands can be displayed by issuing the `help|h|?` command from a Boot PROM prompt. Refer to Section 7.2.4 for a description of the `help` command.

7.2.1 Boot

To reboot the system from a boot PROM prompt, issue the **boot|b** command. The syntax for the **boot** command is:

boot|b [-n] [net|fm]

where:

-n Instructs the Packet Engine not to start runtime execution. Only the Packet Engine image (7pe) is loaded and the boot sequence is then aborted.

net Boots the software over the network. Not implemented in the ASN-9000.

fm Boots the software from Flash Memory.

If a boot source is not specified with the boot command, the boot order configured in NVRAM is used (see Section 7.2.8 for information on the nvram command).

NOTE

The Packet Engine software image (7pe) must be present on the specified boot source. The **boot** command does not affect the boot order specified in nvram.

7.2.2 Copy

To copy a file, or files, from the default device (floppy disk or Flash Memory) issue the copy file (copy|cp) command. Additionally, in the case of the ASN-9000, files located in Flash Memory may be copied by prefacing the filenames with **fm:**.

copy|cp <src-file> <dest-file>
-or-
copy|cp <src-file> [<src-file>...] <device>

The first form copies <src-file> to <dest-file>. The second form copies source file(s) to <device>, preserving filename(s). <src-file> may include wildcard characters.

NOTE

The copy command does not alert the user to the presence of a like-named file on the destination device. Files can be over-written without warning.

7.2.3 Ethernet MAC Address

Each ASN-9000 Packet Engine contains a unique MAC-layer hardware address. This address is assigned at the factory and identifies the Packet Engine, and by extension the chassis containing the Packet Engine. A label on the front panel of the Packet Engine lists the MAC address, and the MAC address is displayed in the boot messages. The **ethaddr** command can be used to display the MAC-layer hardware address of the Packet Engine. The **ethaddr** command displays the following information:

```
<PROM-7pe> ethaddr
Ethernet address: 00-00-ef-03-9a-b0
<PROM-7pe>
```

7.2.4 Help

Help is available from the Boot PROM prompt by issuing the **help** command. Additional help is available for the commands listed by entering **help [command]**. The syntax for the help command is:

help|?|h

Issuing **help** from the boot PROM prompt displays the following screen.

```
<PROM-7pe> ?
COMMANDS:
        boot:           boot|b [-n] [fd|net|fm]
        copy file:      copy|cp <src-file> <dest-file>
                                -or-
                                copy|cp <src-file> [<src-file>...] <device>
        ethaddr:        ethaddr|ea
        help:           help|? [COMMAND]
        expert help:    ??
        ls:             ls|dir
        more:           more [-[<rows>]] f1 [f2...[fn]]
        nvram:          nvram [set|unset|show <variable> [<value>]]
                                ("nvram set bo" sets disk/net boot order)
        remove file:    rm|del [-f] f1 [f2...[fn]]
        rename file:    rename|ren <oldfilename> <newfilename>
        zmodem receive: zreceive|zr|rz [-+27abcehtw] [<filename>]
        zmodem send:    zsend|zs|sz [-+27abehkLlNnoptwXYy]
```

7.2.5 Expert Help

WARNING!

Execution of the additional commands listed under `expert help` are for FORE Systems Technical Assistance Center (TAC) use only. Users are cautioned to not execute any of the commands not listed under the `help` command.

The command listed under expert help are for use by FORE Systems Technical Assistance Center (TAC) only. These commands are designed to aid TAC in diagnosing and troubleshooting the Packet Engine in the event of failure. Users are cautioned not to attempt execution of any of the help commands listed under expert help that are not listed under the help display.

7.2.6 Directory

The **`ls`** and **`dir`** commands display a directory of the files on the default-device. The default-device is the floppy disk on a ASN-9000. Files can also be viewed from the Flash Memory module by preceding the filespec with **`fm:`**. Each command displays the volume name, the files contained on the volume. The **`ls`** and **`dir`** commands display a DOS-like format, including the amount of free space on the volume. These commands differ from the **system ls|dir** commands in that all files on the specified device are listed. The **system ls|dir** commands allow entering a filespec option to filter specific files to be displayed. The syntax for the **ls|dir** commands is:

`ls|dir <`*`filespec`*`>`

where

<filespec> Limits the display to those files meeting <*filespec*>.

An example of the use of the **ls** command listing the system files located in Flash Memory is as follows:

```
<PROM-7PE> ls fm:7*
Volume in device is 10MB FLASH
7PE              1114312    8-26-0205   3:25p
7ATM              274921    8-26-0205   3:25p
2 File(s) 2644200 bytes free
<PROM-7PE>
```

7.2.7 More

The **more** command can be used to display a file located on the floppy diskette or Flash Memory module. The syntax for this command is:

more [-[<rows>]] f1 [f2...[fn]]

where:

-[<rows>] Specifies how many rows of the file are to be displayed at a time.

f1 [f2...[fn]] Specifies a file, or files, to be displayed to the operator console. The file is assumed to be located on the floppy disk. If the file to be displayed resides in the Flash Memory Module, precede the filename with **fm:**.

7.2.8 NVRAM

The **nvram** command is used to set, unset or show initial nvram parameters. The syntax for the **nvram** command is:

nvram [set|unset|show <variable> [<value>]]

where:

set|unset|show Specifies whether to set, unset, or show the nvram variables and/or values specified.

<variable> Specifies which nvram variable to set. The available options are:

bo	boot order, any combination of: f = floppy disk m = flash memory module n = net (not implemented on the ASN-9000)
locbdfile	filename of local bootdef file
netbdfile	filename of net bootdef file (not implemented on the ASN-9000)
myip	local IP address
mysm	local subnet mask
fsip	file server address
gwip	boot gateway address

	crashreboot	sets a boolean value for post-crash behavior
	slotsegs[n]	reserve <num> segments in slot [n]

<value> Specifies the value for the respective <*variable*> above. IP addresses are entered in dotted decimal notation, crashreboot is a boolean value and slotsegs is the number of segments allocated to [n] slot.

7.2.9 Remove File

To remove, delete, a file or files on the default-device, issue the remove file (**`rm|del`**) command. The default-device is the floppy disk on a ASN-9000. On the ASN-9000 files can also be viewed from the Flash Memory module by preceding the filespec with **`fm:`**.

```
rm|del [-f] f1 [f2...[fn]]
```

-f Specifies to use non-interactive mode ("force" deletions). If the -f option is not used, the system responds with `remove` *`filename`*? and the user is required to respond with either '`y`' (yes) or '`n`' (no) to proceed.

f1 [f2...[fn]] Specifies the file, or file list, of files to be removed from the default device.

7.2.10 Rename File

To rename a file on the default-device, issue the rename file (**`rm|del`**) command. The default-device is the floppy disk on a ASN-9000. On the ASN-9000 files can also be renamed from the Flash Memory module by preceding the filespec with **`fm:`**.

```
rename|ren <oldfilename> <newfilename>
```

7.3 Uploading/Downloading Files

This section describes the ZMODEM support available from the Boot PROM command line. The two ZMODEM commands, **`zreceive`** and **`zsend`**, are discussed, as well as procedures to configure the ASN-9000 to utilize these commands.

The ASN-9000 supports ZMODEM file transfer protocol. Using the ZMODEM commands, files can be copied between the ASN-9000 and a PC or Macintosh running a ZMODEM protocol application. Files transferred using these commands are sent or received to or from the ASN-9000 default-device. The default-device on a ASN-9000 is the floppy disk. If the PC or Macintosh supports XMODEM, the ZMODEM commands can be used to perform XMODEM transfers. To use the ZMODEM commands, a PC or Macintosh supporting ZMODEM must be connected to TTY1 or TTY2:

- If the management terminal on TTY1 contains the ZMODEM or XMODEM application, ASN-9000 commands can be issued to set up the transfer, then switch to the ZMODEM or XMODEM application to activate the transfer.
- Alternatively, the transfer can be set up from the management terminal on TTY1, then use the ZMODEM or XMODEM application on the device connected to TTY2 to complete the transfer.

7.3.1 ZMODEM Receive

The **zreceive** command prepares the ASN-9000 to receive a file. After issuing the **zreceive** command, the ZMODEM or XMODEM application on the PC or Macintosh must be used to actually begin the transfer.

The **zreceive** command provides numerous options, but the defaults for those options are appropriate for most file transfers. The defaults are the same for XMODEM transfers, except that a file name must be specified. File names are not necessary when performing a ZMODEM transfer. The syntax for the **zreceive** command is:

zreceive|zr|rz [-+27abcehtw] [<filename>]

where:

- Introduces the argument list. If any arguments are specified, the argument list must be preceded by the **-** (hyphen). If arguments are not specified, do not use the **-** (hyphen).

+ Causes the file being received to be appended to an already existing file. Specify the file name at the end of the argument list (ex: zr -+ae asn1.log).

2 Causes the file transfer to take place through the TTY2 port, rather than the TTY1 port. By default, the transfer takes place over the TTY1 port.

7 Uses 7-bit bytes for the transfer. By default the ZMODEM program uses 8-bit bytes.

a	Performs the transfer in ASCII mode, using the appropriate newline translation. By default, the transfer takes place in binary mode.
b	Performs the transfer in binary mode. Binary is the default transfer mode.
c	XMODEM only. Uses a 16-bit CRC.
e	Ignores control characters.
h	Sets the serial baud rate to 19.2 Kpbs.
t	Sets the receive timeout to N / 10 seconds (10 <= N <= 1000). Specify the file name at the end of the argument list (ex: zr -at 500). The default is 100; that is, 10 seconds.
w	Sets the protocol window to N bytes. Specify the file name at the end of the argument list (ex: zr -aw 10).
<filename>	Entering a filename causes the XMODEM protocol to be used. If using ZMODEM protocol it is not necessary to specify a file name.

NOTE

The **`zreceive`** command only transfer files to the floppy disk. Use the **`copy|cp`** command to transfer the file(s) to the Flash Memory module.

If a filename is not specified, or none of the optional arguments are specified, the ASN-9000 uses the ZMODEM protocol to receive the file on TTY1, in binary mode, using 8-bit bytes. When the **zr** command is executed on the ASN-9000, the ZMODEM application on the PC or Macintosh must be used to specify the file to be transferred and to perform the transfer.

Following are some examples of the use of the **`zreceive`** command. After issuing the command on the ASN-9000, use the appropriate protocol application on the PC or Macintosh to transfer the file.

In the first example, ZMODEM is used to prepare the ASN-9000 to receive a binary file from a PC or Macintosh. All defaults are used. Notice that no file name is specified. When using ZMODEM, specify the file name on the PC or Macintosh.

```
<PROM 7pe> zreceive
```

In the following example, the ASN-9000 is prepared to receive a configuration file from a PC or Macintosh. All defaults are accepted, except the default for transfer mode. The **a** argument is used to change the transfer mode to ASCII, which is appropriate for ASN-9000 configuration, environment, and boot definition files. Notice that the hyphen (-) is used to introduce the argument list.

```
<PROM 7pe> zreceive -a
```

The following example shows how the ASN-9000 is prepared to upload a file using XMODEM. Because, XMODEM, unlike ZMODEM, does not send filenames from the sending device, the receiving device (the ASN-9000 in this case) must supply the file name.

```
PROM 7pe> zreceive 7pe
```

In the following example, ZMODEM is used to prepare the ASN-9000 to upload an ASCII file from the PC or Macintosh connected to TTY2. The **t** argument is used to specify the receive timeout. Notice that the receive timeout is specified after the argument list.

```
<PROM 7pe> zreceive -2a 10
```

If XMODEM were used instead of ZMODEM, the file name would follow the value **10**, as shown in the following example.

```
<PROM 7pe> zreceive -2a 10 monitor.env
```


7.3.2 ZMODEM Send

The **zsend** command is used to download a file from the ASN-9000 to a PC or Macintosh. This command can be used to perform transfers to devices supporting ZMODEM or YMODEM. Like the **zreceive** command, the **zsend** command provides many options, but the defaults for these options are appropriate for most transfers. The syntax for this command is:

zsend|zs|sz [-+27abehkLlNnoptwXYy]

where:

- Introduces the argument list. If any arguments are specified, the argument list must be preceded by a - (hyphen). If arguments are not to be used, do not specify the - (hyphen).

+ ZMODEM only. Causes the file to be appended to an existing file. Specify the file name at the end of the argument list (ex: zs -+a asn2.log).

2 Causes the file transfer to take place through the TTY2 port, rather than the TTY1 port. By default, the transfer takes place over the TTY1 port.

7 Uses 7-bit bytes for the transfer. By default the ZMODEM program uses 8-bit bytes.

a Performs the transfer in ASCII mode, using the appropriate newline translation. By default, the transfer takes place in binary mode.

b Performs the transfer in binary mode. Binary is the default transfer mode.

e ZMODEM only. Escapes all control characters.

h Sets the port baud rate to 19.2 Kpbs.

k YMODEM only. Transfers the file in 1024-byte packets.

L ZMODEM only. Limits the subpacket length to N bytes. Specify the file name at the end of the argument list (ex: **zs -aL 64**).

l ZMODEM only. Limits the frame length to N bytes (l>=L). Specify the file name at the end of the argument list (ex: **zs -al 64**).

N ZMODEM only. Transfers the file only if the version on the ASN-9000 is both newer and longer than the version on the PC or Macintosh. Otherwise, the file is not transferred.

n ZMODEM only. Similar to N, except the file is transferred if it is newer, even if it is not longer than the identically named file on the PC or Macintosh.

o ZMODEM only. Uses 16-bit CRC rather than the default 32-bit CRC.

p ZMODEM only. Protects the file specified by <*file-name*> if it already exists on the PC or Macintosh. If the file is already present on the device, it is not overwritten by the file on the ASN-9000.

t Sets the receive timeout to N / 10 seconds (10 <= N <= 1000). Specify the filename at the end of the argument list (ex: zs -at 500). The default is 600 (60 seconds).

w ZMODEM only. Sets the protocol window to N bytes. Specify the filename at the end of the argument list (ex: zs -aw 10).

X Uses the XMODEM protocol, rather than the ZMODEM protocol. Note that some of the other arguments are not valid with the ZMODEM protocol.

Y ZMODEM only. Overwrites the file specified by <*file-name*>, but skips the file altogether if the file is not present on the PC or Macintosh. If the file specified by <*file-name*> is not already present on the PC or Macintosh, the file is not written to that device.

y ZMODEM only. Overwrites the file specified by <*file-name*>. Unlike Y, the y argument does not skip the file if it is not on the PC or Macintosh. Even if the file is not on the device, the ASN-9000 writes the file to the device.

Following are some examples of the use of the **zsend** command. The first example uses ZMODEM to send a software image file from the PC or Macintosh. All the **zsend** defaults are used.

```
<PROM-PE> zsend fore/images/7pe
```

In the following example, an environment file is sent to the PC or Macintosh connected to TTY1. The **a** argument is used to change the transfer mode to ASCII, which is appropriate for ASN-9000 configuration, environment, and boot definition files. In addition, the **N** argument is used to ensure that the file is transferred only if it is newer and longer than the identically named file on the PC or Macintosh. Notice that the hyphen (**-**) is used to introduce the argument list and no spaces separate the arguments in the list. A space does separate the file name from the argument list.

```
<PROM 7pe> zsend -aM root.env
```

APPENDIX A Balancing Bandwidth

The packet-forwarding capacity of a system as measured in bits-per-second is determined by the bandwidth of the system's buses and buffer memories. In the case of the ASN-9000, the packet-forwarding capacity is determined by the bandwidth of the Packet Channels and the Shared Memory of the Packet Engine.

Depending on the bandwidth utilization in the network, two basic types of configurations can be implemented:

Non-blocking The system has sufficient bandwidth to forward all packets when all segments are being offered traffic at the maximum theoretical bit-per-second rate ("wire speed"). In a non-blocking configuration, the NIMs are distributed in such a way that neither the Packet Channels nor the Packet Engine's Shared Memory can ever be offered more bandwidth than it can handle. Non-blocking configurations are important in networks that experience frequent, sustained periods of peak bandwidth utilization

Blocking The theoretical maximum wire speed exceeds the bandwidth of the Packet Channels and Shared Memory. In a blocking configuration, individual networks can have peak bandwidth requirements that approach 100% of the theoretical maximum wire speed, but the system configuration does not support sustained, simultaneous peak bandwidth usage on all segments.

Although the ASN-9000 architecture is designed to balance high throughput with processing power, it is possible for some configurations, during peak utilization, to overload the capacity of the Packet Channels and the Shared Memory. In addition, the Packet Engine's Shared Memory can become overloaded if the combined bandwidth offered by the Packet Channels is greater than the maximum amount the Shared Memory can receive.

Each Packet Channel can accommodate loads of up to 800 Mb/s; the Shared Memory can accommodate from 640 – 720 Mb/s. If the total load offered by the modules connected to a Packet Channel exceeds 800 Mb/s, the Packet Channel is unable to accept the entire load. As a result, some packets might be dropped. Similarly, if the load offered by the Packet Channels exceeds the capacity of the Shared Memory, some packets might be dropped.

Most networks rarely operate at peak utilization over sustained periods. Moreover, during brief periods of peak utilization (generally less than one second), the on-board Shared Memory of intelligent modules, buffers the packets, preventing them from being dropped. Additionally, higher-layer protocols, such as Van Jacobsen's slow-start algorithm for TCP, quickly reduce the offered load to a level the system can sustain during these peak periods.

A.1 Non-Blocking Configurations

A non-blocking configuration for the Packet Channel exists if the total peak load for the Packet Channel is lower than 800 Mb/s. A blocking configuration exists if the total is higher than 800 Mb/s. Consider rearranging the NIMs in the chassis until a non-blocking configuration exists. *Chapter 2, Chassis and Packet Engine* explains how the slots map to the Packet Channels on the ASN-9000.

A non-blocking configuration also exists if the total peak Shared Memory load is lower than 640 – 720 Mb/s for all Packet Channels. A blocking configuration exists if the total is higher than 720 Mb/s.

A.2 Blocking Configurations

Although a non-blocking configuration is always desirable, if a non-blocking configuration is not possible, a blocking configuration can be achieved that does not impair the throughput on the network.

The bandwidth requirements for a blocking configuration depend upon the amount of blocking that is acceptable for the network. For example, if the peak utilization on the network rarely exceeds 50% of the maximum bandwidth supported by the NIMs, a 50% blocking configuration can be implemented. Note that "peak utilization" refers to the total load offered at any time by all the segments attached to a Packet Channel or Shared Memory. For example, if half of the segments are running at 100% and half are running at 50%, then the peak utilization is 75%, not 100%. If the network is expected to achieve a peak utilization of 75%, a 75% blocking configuration can be implemented without impairing the throughput on the network.

If the total peak load for a Packet Channel is lower than 800 Mb/s, the configuration meets the peak utilization target for that Packet Channel. If the total is higher than 800 Mb/s, consider rearranging the NIMs in the chassis.

If the total peak Shared Memory load is lower than 640 to 720 Mb/s, the configuration meets the peak utilization target for the Shared Memory. If the total is higher than 720 Mb/s, packet loss may be experienced if the network is as busy as estimated. Statistics in the **bridge** subsystem can help determine the current and peak utilization of network segments and whether packet loss is occurring. Refer to the *ATM Service Node 9000 Software Reference Manual*.

Acronyms

The networking terms in the following list are defined in the Glossary of this manual. Glossary items are listed alphabetically according to the full term.

AAL	ATM Adaptation Layer
ABR	Available Bit Rate
ACM	Address Complete Message
ACR	Allowable Cell Rate
ADPCM	Adaptive Differential Pulse Code Modulation
AHFG	ATM-attached Host Functional Group
AIMUX	ATM Inverse Multiplexing
AIS	Alarm Indication Signal
AMI	Alternate Mark Inversion
AMI	ATM Management Interface
ANSI	American National Standards Institute
APCM	Adaptive Pulse Code Modulation
API	Application Program Interface
APP	Application Program
APS	Automatic Protection Switching
ARP	Address Resolution Protocol
ASCII	American Standard Code for Information Interchange
ATDM	Asynchronous Time Division Multiplexing
ATM	Asynchronous Transfer Mode
AUI	Attachment User Interface
B8ZS	Bipolar 8 Zero Substitution
BCOB	Broadband Connection Oriented Bearer
BCOB-A	Bearer Class A
BCOB-C	Bearer Class C
BCOB-X	Bearer Class X
BECN	Backward Explicit Congestion Notification
BER	Bit Error Rate
BES	Bursty Errored Seconds
BGP	Border Gateway Protocol
B-ICI	B-ISDN Inter-Carrier Interface.
BIP	Bit Interleaved Parity
B-ISDN	Broadband Integrated Services Digital Network
B-ISUP	Broadband ISDN User’s Part
BITS	Building Integrated Timing Supply
BNC	Bayonet-Neill-Concelman

BPDU	Bridge Protocol Data Unit
bps	Bits per Second
BPV	Bipolar Violation
B-TE	Broadband Terminal Equipment
BUS	Broadcast and Unknown Server
CAC	Connection Admission Control
CAS	Channel Associated Signaling
CBDS	Connectionless Broadband Data Service
CBR	Constant Bit Rate
CCITT	International Telephone and Telegraph Consultative Committee
CCS	Common Channel Signaling
CDV	Cell Delay Variation
CE	Connection Endpoint
CEI	Connection Endpoint Identifier
CES	Circuit Emulation Service
CGA	Carrier Group Alarm
CIP	Carrier Identification Parameter
CIR	Committed Information Rate
CLIP	Classical IP
CLP	Cell Loss Priority
CLR	Cell Loss Ratio-1-15
CLS	Connectionless service
CMIP	Common Management Interface Protocol
CMR	Cell Misinsertion Rate
CPE	Customer Premise Equipment
CRA	Cell Rate Adaptation
CRC	Cyclic Redundancy Check
CRS	Cell Relay Service
CS	Controlled Slip, **or** Convergence Sublayer
CSU	Channel Service Unit
CTD	Cell Transfer Delay
CTS	Clear To Send
DACS	Digital Access and Cross-Connect System
DARPA	Defense Advanced Research Projects Agency
DCC	Data Country Code
DCE	Data Communications Equipment
DCS	Digital Cross-connect System
DES	Destination End Station
DFA	DXI Frame Address
DLCI	Data Link Connection Identifier
DNS	Domain Naming System
DSn	Digital Standard n (n=0, 1, 1C, 2, and 3)

DSR	Data Set Ready
DTE	Data Terminal Equipment
DTR	Data Terminal Ready
EEPROM	Electrically Erasable Programmable Read Only Memory
EFCI	Explicit Forward Congestion Indication
EGP	Exterior Gateway Protocol
EIA	Electronics Industries Association
EISA	Extended Industry Standard Architecture
ELAN	Emulated Local Area Network
EMI	Electromagnetic Interference
EPROM	Erasable Programmable Read Only Memory
EQL	Equalization
ER	Explicit Rate
ES	End System, **or**
	Errored Second
ESF	Extended Super Frame
ESI	End System Identifier
EXZ	Excessive Zeroes (Error Event)
FC	Face Contact
FCC	Federal Communications Commission
FCS	Frame Check Sequence
FDDI	Fiber Distributed Data Interface
FDM	Frequency Division Multiplexing
FEBE	Far End Block Error
FEC	Forward Error Correction
FECN	Forward Explicit Congestion Notification
FERF	Far End Receive Failure
FIFO	First-In, First-Out
FRS	Frame-Relay Service
FTP	File Transfer Protocol
FT-PNNI	ForeThought PNNI
FUNI	Frame-Based UNI
GCAC	Generic Connection Admission Control
GCRA	Generic Cell Rate Algorithm
GFC	Generic Flow Control
HDB3	High Density Bipolar
HDLC	High Level Data Link Control
HEC	Header Error Control
HIPPI	High Performance Parallel Interface
HSSI	High-Speed Serial Interface
ICMP	Internet Control Message Protocol
IDU	Interface Data Unit
IEEE	Institute of Electrical and Electronics Engineers

IETF	Internet Engineering Task Force
ILMI	Interim Local Management Interface
IP	Internet Protocol
IPX	Internetwork Packet Exchange
IS	Intermediate system
ISDN	Integrated Services Digital Network
ISO	International Standards Organization
ITU-T	International Telecommunication Union Telecommunication
IWF	Interworking Function
IXC	Interexchange Carriers
JPEG	Joint Photographic Experts Group
Kbps	Kilobits per second
LAN	Local Area Network
LANE	LAN Emulation
LAPB	Link Access Procedure, Balanced
LATA	Local Access and Transport Area
LBO	Line Build Out
LCV	Line Code Violations
LE_ARP	LAN Emulation Address Resolution Protocol
LEC	LAN Emulation Client
LECS	LAN Emulation Configuration Server
LES	LAN Emulation Server
LLC	Logical Link Control
LOF	Loss Of Frame
LOP	Loss Of Pointer
LOS	Loss Of Signal
LSB	Least Significant Bit
MAC	Media Access Control
MAN	Metropolitan Area Network
MAU	Media Attachment Unit
MBS	Maximum Burst Size
MCDV	Maximum Cell Delay Variance
MCLR	Maximum Cell Loss Ratio
MCR	Minimum Cell Rate
MCTD	Maximum Cell Transfer Delay
MIB	Management Information Base
MIC	Media Interface Connector
MID	Message Identifier
MMF	Multimode Fiber Optic Cable
MPEG	Motion Picture Experts Group
MPOA	Multiprotocol over ATM
MSB	Most Significant Bit
MTU	Maximum Transmission Unit

NM	Network Management Entity
NML	Network Management Layer
NMS	Network Management Station
NNI	Network-to-Network Interface or Network Node Interface
NPC	Network Parameter Control
NRZ	Non Return to Zero
NRZI	Non Return to Zero Inverted
NSAP	Network Service Access Point
NTSC	National TV Standards Committee
OAM	Operation and Maintenance Cell
OC-n	Optical Carrier level-n
OID	Object Identifier
OOF	Out-of-Frame
OSI	Open Systems Interconnection
OSPF	Open Shortest Path First Protocol
OUI	Organizationally Unique Identifier
PAD	Packet Assembler Disassembler
PAL	Phase Alternate Line
PBX	Private Branch Exchange
PCI	Peripheral Component Interconnect
PCM	Pulse Code Modulation
PCR	Peak Cell Rate
PDN	Public Data Network
PDU	Protocol Data Unit
PHY	Physical Layer
ping	Packet Internet Groper
PLCP	Physical Layer Convergence Protocol
PLP	Packet Level Protocol
PM	Physical Medium
PMD	Physical Medium Dependent
PNNI	Private Network Node Interface or Private Network-to-Network Interface
PPP	Point-to-Point Protocol
PROM	Programmable Read-Only Memory
PRS	Primary Reference Source
PSN	Packet Switched Network
PT	Payload Type
PVC	Permanent Virtual Circuit (or Channel)
PVCC	Permanent Virtual Channel Connection
PVPC	Permanent Virtual Path Connection
QD	Queuing Delay
QoS	Quality of Service
RD	Routing Domain
RFCs	Requests For Comment

RFI	Radio Frequency Interference
RIP	Routing Information Protocol
RISC	Reduced Instruction Set Computer
RTS	Request To Send
SA	Source Address
SA	Source MAC Address
SAP	Service Access Point
SAR	Segmentation And Reassembly
SC	Structured Cabling, **or** Structured Connectors, **or** Stick and Click
SCR	Sustainable Cell Rate
SCSI	Small Computer Systems Interface
SDLC	Synchronous Data Link Control
SDU	Service Data Unit
SEAL	Simple and Efficient Adaptation Layer
SECAM	Systeme En Coleur Avec Memoire
SEL	Selector
SES	Severely Errored Seconds
SF	Super Frame
SGMP	Simple Gateway Management Protocol
SIR	Sustained Information Rate
SLIP	Serial Line IP
SMDS	Switched Multimegabit Data Service
SMF	Single Mode Fiber
SMTP	Simple Mail Transfer Protocol
SNA	Systems Network Architecture
SNAP	SubNetwork Access Protocol
SNI	Subscriber Network Interface
SNMP	Simple Network Management Protocol
SONET	Synchronous Optical Network
SPANS	Simple Protocol for ATM Network Signalling
SPARC	Scalable Processor Architecture Reduced instruction set Computer
SPE	Synchronous Payload Envelope
SPVC	Smart PVC
SS7	Signaling System No. 7
SSCOP	Service Specific Connection Oriented Protocol
SSCS	Service Specific Convergence Sublayer
ST	Straight Tip, **or** Stick and Turn
STM	Synchronous Transfer Mode
STP	Shielded Twisted Pair, Spanning Tree Protocol
STS	Synchronous Transport Signal

SVC	Switched Virtual Circuit (or Channel)
SVCC	Switched Virtual Channel Connection
SVPC	Switched Virtual Path Connection
TAXI	Transparent Asynchronous Transmitter / Receiver Interface
TC	Transmission Convergence
TCP	Transmission Control Protocol
TCP/IP	Transmission Control Protocol / Internet Protocol
TCR	Tagged Cell Rate
TCS	Transmission Convergence Sublayer
TDM	Time Division Multiplexing
TE	Terminal Equipment
TFTP	Trivial File Transfer Protocol
TM	Traffic Management
UAS	Unavailable Seconds
UBR	Unspecified Bit Rate
UDP	User Datagram Protocol
UNI	User-to-Network Interface
UPC	Usage Parameter Control
UTOPIA	Universal Test & Operations Interface for ATM
UTP	Unshielded Twisted Pair
VBR	Variable Bit Rate
VC	Virtual Channel (or Circuit)
VCC	Virtual Channel Connection
VCI	Virtual Channel Identifier
VCL	Virtual Channel Link
VINES	Virtual Network Software
VLAN	Virtual Local Area Network
VP	Virtual Path
VPC	Virtual Path Connection
VPDN	Virtual Private Data Network
VPI	Virtual Path Identifier
VPL	Virtual Path Link
VPN	Virtual Private Network
VPT	Virtual Path Terminator
VS/VD	Virtual Source / Virtual Destination
VT	Virtual Tributary
WAN	Wide-Area Network
ZBTSI	Zero Byte Time Slot Interchange

Glossary

10Base-T - a 10 Mbps baseband Ethernet specification utilizing twisted-pair cabling (Category 3, 4, or 5). 10BaseT, which is part of the IEEE 802.3 specification, has a distance limit of approximately 100 meters per segment.

802.1d Spanning Tree Bridging - the IEEE standard for bridging; a MAC layer standard for transparently connecting two or more LANs (often called subnetworks) that are running the same protocols and cabling. This arrangement creates an extended network, in which any two workstations on the linked LANs can share data.

802.3 Ethernet - the IEEE standard for Ethernet; a physical-layer standard that uses the CSMA / CD access method on a bus-topology LAN.

802.5 Token Ring - the IEEE physical-layer standard that uses the token-passing access method on a ring-topology LAN.

AAL Connection - an association established by the AAL between two or more next higher layer entities.

Adapter - A fitting that supplies a passage between two sets of equipment when they cannot be directly interconnected.

Adaptive Differential Pulse Code Modulation (ADPCM) - A technique that allows analog voice signals to be carried on a 32K bps digital channel. Sampling is done at 8Hz with 4 bits used to describe the difference between adjacent samples.

Adaptive Pulse Code Modulation (APCM) - A technique that effectively reduces occupied bandwidth per active speaker by reducing sampling rates during periods of overflow peak traffic.

Address - A unique identity of each network station on a LAN or WAN.

Address Complete Message (ACM) - A B-ISUP call control message from the receiving exchange to sending exchange indicating the completion of address information.

Address Mask - a bit mask used to identify which bits in an address (usually an IP address) are network significant, subnet significant, and host significant portions of the complete address. This mask is also known as the subnet mask because the subnetwork portion of the address can be determined by comparing the binary version of the mask to an IP address in that subnet. The mask holds the same number of bits as the protocol address it references.

Address Prefix - A string of 0 or more bits up to a maximum of 152 bits that is the lead portion of one or more ATM addresses.

Address Resolution - The procedure by which a client associates a LAN destination with the ATM address of another client or the BUS.

Address Resolution Protocol (ARP) - a method used to resolve higher level protocol addressing (such as IP) into the appropriate header data required for ATM; i.e., port, VPI, and VCI; also defines the AAL type to be used.

Agent - a component of network- and desktop-management software, such as SNMP, that gathers information from MIBs.

alarm - an unsolicited message from a device, typically indicating a problem with the system that requires attention.

Alarm Indication Signal (AIS) - In T1, an all ones condition used to alert a receiver that its incoming signal (or frame) has been lost. The loss of signal or frame is detected at the receiving end, and the failed signal is replaced by all the ones condition which the receiver interprets as an AIS. The normal response to this is AIS is for the receiving end to generate a yellow alarm signal as part of its transmission towards the faulty end. (The AIS itself is sometimes called a Blue Signal).

A-Law - The PCM coding and companding standard used in Europe.

Allowable Cell Rate (ACR) - parameter defined by the ATM Forum for ATM traffic management. ACR varies between the MCR and the PCR, and is dynamically controlled using congestion control mechanisms.

Alternate Mark Inversion (AMI) - A line coding format used on T1 facilities that transmits ones by alternate positive and negative pulses.

Alternate Routing - A mechanism that supports the use of a new path after an attempt to set up a connection along a previously selected path fails.

American National Standards Institute (ANSI) - a private organization that coordinates the setting and approval of some U.S. standards. It also represents the United States to the International Standards Organization.

American Standard Code for Information Interchange (ASCII) - a standard character set that (typically) assigns a 7-bit sequence to each letter, number, and selected control characters.

AppleTalk - a networking protocol developed by Apple Computer for communication between Apple's products and other computers. Independent of the network layer, AppleTalk runs on LocalTalk, EtherTalk and TokenTalk.

Application Layer - Layer seven of the ISO reference model; provides the end-user interface.

Application Program (APP) - a complete, self-contained program that performs a specific function directly for the user.

Application Program Interface (API) - a language format that defines how a program can be made to interact with another program, service, or other software; it allows users to develop custom interfaces with FORE products.

Assigned Cell - a cell that provides a service to an upper layer entity or ATM Layer Management entity (ATMM-entity).

asxmon - a FORE program that repeatedly displays the state of the switch and its active ports.

Asynchronous Time Division Multiplexing (ATDM) - a multiplexing technique in which a transmission capability is organized into a priori, unassigned time slots. The time slots are assigned to cells upon request of each application's instantaneous real need.

Asynchronous Transfer Mode (ATM) - a transfer mode in which the information is organized into cells. It is asynchronous in the sense that the recurrence of cells containing information from an individual user is not necessarily periodic.

ATM Adaptation Layer (AAL) - the AAL divides user information into segments suitable for packaging into a series of ATM cells. AAL layer types are used as follows:

AAL-1 - constant bit rate, time-dependent traffic such as voice and video
AAL-2 - still undefined; a placeholder for variable bit rate video transmission
AAL-3/4 - variable bit rate, delay-tolerant data traffic requiring some sequencing and/or error detection support (originally two AAL types, connection-oriented and connectionless, which have been combined)
AAL-5 - variable bit rate, delay-tolerant, connection-oriented data traffic requiring minimal sequencing or error detection support

ATM Address - Defined in the UNI Specification as 3 formats, each having 20 bytes in length.

ATM Forum - an international non-profit organization formed with the objective of accelerating the use of ATM products and services through a rapid convergence of interoperability specifications. In addition, the Forum promotes industry cooperation and awareness.

ATM Inverse Multiplexing (AIMUX) - A device that allows multiple T1 or E1 communications facilities to be combined into a single broadband facility for the transmission of ATM cells.

ATM Layer link - a section of an ATM Layer connection between two adjacent active ATM Layer entities (ATM-entities).

ATM Link - a virtual path link (VPL) or a virtual channel link (VCL).

ATM Management Interface (AMI) - the user interface to FORE Systems' *ForeThought* switch control software (SCS). AMI lets users monitor and change various operating configurations of FORE Systems switches and network module hardware and software, IP connectivity, and SNMP network management.

ATM Peer-to-Peer Connection - a virtual channel connection (VCC) or a virtual path connection (VPC) directly established, such as workstation-to-workstation. This setup is not commonly used in networks.

ATM Traffic Descriptor - a generic list of parameters that can be used to capture the intrinsic traffic characteristics of a requested ATM connection.

ATM User-to-User Connection - an association established by the ATM Layer to support communication between two or more ATM service users (i.e., between two or more next higher layer entities or between two or more ATM entities). The communication over an ATM Layer connection may be either bidirectional or unidirectional. The same Virtual Channel Identifier (VCI) is used for both directions of a connection at an interface.

atmarp - a FORE program that shows and manipulates ATM ARP entries maintained by the given device driver. This is also used to establish PVC connections.

ATM-attached Host Functional Group (AHFG) - The group of functions performed by an ATM-attached host that is participating in the MPOA service.

atmconfig - a FORE program used to enable or disable SPANS signaling.

atmstat - a FORE program that shows statistics gathered about a given adapter card by the device driver. These statistics include ATM layer and ATM adaptation layer cell and error counts. This can also be used to query other hosts via SNMP.

Attachment User Interface (AUI) - IEEE 802.3 interface between a media attachment unit (MAU) and a network interface card (NIC). The term AUI can also refer to the rear panel port to which an AUI cable might attach.

Auto-logout - a feature that automatically logs out a user if there has been no user interface activity for a specified length of time.

Automatic Protection Switching (APS) - Equipment installed in communications systems to detect circuit failures and automatically switch to redundant, standby equipment.

Available Bit Rate (ABR) - a type of traffic for which the ATM network attempts to meet that traffic's bandwidth requirements. It does not guarantee a specific amount of bandwidth and the end station must retransmit any information that did not reach the far end.

Backbone - the main connectivity device of a distributed system. All systems that have connectivity to the backbone connect to each other, but systems can set up private arrangements with each other to bypass the backbone to improve cost, performance, or security.

Backplane - High-speed communications line to which individual components are connected.

Backward Explicit Congestion Notification (BECN) - A Resource Management cell type generated by the network or the destination, indicating congestion or approaching congestion for traffic flowing in the direction opposite that of the BECN cell.

Bandwidth - usually identifies the capacity or amount of data that can be sent through a given circuit; may be user-specified in a PVC.

Baud - unit of signalling speed, equal to the number of discrete conditions or signal events per second. If each signal event represents only one bit, the baud rate is the same as bps; if each signal event represents more than one bit (such as a dibit), the baud rate is smaller than bps.

Bayonet-Neill-Concelman (BNC) - a bayonet-locking connector used to terminate coaxial cables. BNC is also referred to as Bayonet Network Connector.

Bipolar 8 Zero Substitution (B8ZS) - a technique used to satisfy the ones density requirements of digital T-carrier facilities in the public network while allowing 64 Kbps clear channel data. Strings of eight consecutive zeroes are replaced by an eight-bit code representing two intentional bipolar pulse code violations (000V10V1).

Bipolar Violation (BPV) - an error event on a line in which the normal pattern of alternating high (one) and low (zero) signals is disrupted. A bipolar violation is noted when two high signals occur without an intervening low signal, or vice versa.

B-ISDN Inter-Carrier Interface (B-ICI) - An ATM Forum defined specification for the interface between public ATM networks to support user services across multiple public carriers.

Bit Error Rate (BER) - A measure of transmission quality, generally shown as a negative exponent, (e.g., 10^{-7} which means 1 out of 10^7 bits [1 out of 10,000,000 bits] are in error).

Bit Interleaved Parity (BIP) - an error-detection technique in which character bit patterns are forced into parity, so that the total number of one bits is always odd or always even. This is accomplished by the addition of a one or zero bit to each byte, as the byte is transmitted; at the other end of the transmission, the receiving device verifies the parity (odd or even) and the accuracy of the transmission.

Bit Robbing - The use of the least significant bit per channel in every sixth frame for signaling.

Bit Stuffing - A process in bit-oriented protocols where a zero is inserted into a string of ones by the sender to prevent the receiver from interpreting valid user data (the string of ones) as control characters (a Flag character for instance).

Border Gateway Protocol (BGP) - used by gateways in an internet connecting autonomous networks. It is derived from experiences learned using the EGP.

bps - bits per second

Bridge - a device that expands a Local Area Network by forwarding frames between data link layers associated with two separate cables, usually carrying a common protocol. Bridges can usually be made to filter certain packets (to forward only certain traffic).

Bridge Protocol Data Unit (BPDU) - A message type used by bridges to exchange management and control information.

Broadband - a service or system requiring transmission channels capable of supporting rates greater than the Integrated Services Digital Network (ISDN) primary rate.

Broadband Access - an ISDN access capable of supporting one or more broadband services.

Broadband Connection Oriented Bearer (BCOB) - Information in the SETUP message that indicates the type of service requested by the calling user.

BCOB-A (Bearer Class A) - Indicated by ATM end user in SETUP message for connection-oriented, constant bit rate service. The network may perform internetworking based on AAL information element (IE).

BCOB-C (Bearer Class C) - Indicated by ATM end user in SETUP message for connection-oriented, variable bit rate service. The network may perform internetworking based on AAL information element (IE).

BCOB-X (Bearer Class X) - Indicated by ATM end user in SETUP message for ATM transport service where AAL, traffic type and timing requirements are transparent to the network.

Broadband Integrated Services Digital Network (B-ISDN) - a common digital network suitable for voice, video, and high-speed data services running at rates beginning at 155 Mbps.

Broadband ISDN User's Part (B-ISUP) - A protocol used to establish, maintain and release broadband switched network connections across an SS7/ATM network.

Broadband Terminal Equipment (B-TE) - An equipment category for B-ISDN which includes terminal adapters and terminals.

Broadcast - Data transmission to all addresses or functions.

Broadcast and Unknown Server (BUS) - in an emulated LAN, the BUS is responsible for accepting broadcast, multicast, and unknown unicast packets from the LECs to the broadcast MAC address (FFFFFFFFFFFF) via dedicated point-to-point connections, and forwarding the packets to all of the members of the ELAN using a single point-to-multipoint connection.

Brouter (bridging/router) - a device that routes some protocols and bridges others based on configuration information.

Buffer - A data storage medium used to compensate of a difference in rate of data flow or time of occurrence of events when transmitting data from one device to another.

Building Integrated Timing Supply (BITS) - a master timing supply for an entire building, which is a master clock and its ancillary equipment. The BITS supplies DS1 and/or composite clock timing references for synchronization to all other clocks and timing sources in that building.

Bursty Errored Seconds (BES) - a BES contains more than 1 and fewer than 320 path coding violation error events, and no severely errored frame or AIS defects. Controlled slips are not included in determining BESs.

Bursty Second - a second during which there were at least the set number of BES threshold event errors but fewer than the set number of SES threshold event errors.

Byte - A computer-readable group of bits (normally 8 bits in length).

Call - an association between two or more users or between a user and a network entity that is established by the use of network capabilities. This association may have zero or more connections.

Carrier - a company, such as any of the "baby Bell" companies, that provide network communications services, either within a local area or between local areas.

Carrier Group Alarm (CGA) - A service alarm generated by a channel bank when an out-of-frame (OOF) condition exists for some predetermined length of time (generally 300 milliseconds to 2.5 seconds). The alarm causes the calls using a trunk to be dropped and trunk conditioning to be applied.

Carrier Identification Parameter (CIP) - A 3 or 4 digit code in the initial address message identifying the carrier to be used for the connection.

cchan - a FORE program that manages virtual channels on a *ForeRunner* switch running `asxd`.

Cell - an ATM Layer protocol data unit (PDU). The basic unit of information transported in ATM technology, each 53-byte cell contains a 5-byte header and a 48-byte payload.

Cell Delay Variation (CDV) - a quantification of cell clumping for a connection. The cell clumping CDV (yk) is defined as the difference between a cell's expected reference arrival time (ck) and its actual arrival time (ak). The expected reference arrival time (ck) of cell k of a specific connection is max. T is the reciprocal of the negotiated peak cell rate.

Cell Delineation - the protocol for recognizing the beginning and end of ATM cells within the raw serial bit stream.

Cell Header - ATM Layer protocol control information.

Cell Loss Priority (CLP) - the last bit of byte four in an ATM cell header; indicates the eligibility of the cell for discard by the network under congested conditions. If the bit is set to 1, the cell may be discarded by the network depending on traffic conditions.

Cell Loss Ratio - In a network, cell loss ratio is (1-x/y), where y is the number of cells that arrive in an interval at an ingress of the network; and x is the number of these y cells that leave at the egress of the network element.

Cell Loss Ratio (CLR) - CLR is a negotiated QoS parameter and acceptable values are network specific. The objective is to minimize CLR provided the end-system adapts the traffic to the changing ATM layer transfer characteristics. The Cell Loss Ratio is defined for a connection as: Lost Cells/Total Transmitted Cells. The CLR parameter is the value of CLR that the network agrees to offer as an objective over the lifetime of the connection. It is expressed as an order of magnitude, having a range of 10-1 to 10-15 and unspecified.

Cell Misinsertion Rate (CMR) - the ratio of cells received at an endpoint that were not originally transmitted by the source end in relation to the total number of cells properly transmitted.

Cell Rate Adaptation (CRA) - a function performed by a protocol module in which empty cells (known as unassigned cells) are added to the output stream. This is because there always must be a fixed number of cells in the output direction; when there are not enough cells to transmit, unassigned cells are added to the output data stream.

Cell Relay Service (CRS) - a carrier service which supports the receipt and transmission of ATM cells between end users in compliance with ATM standards and implementation specifications.

Cell Transfer Delay - the transit delay of an ATM cell successfully passed between two designated boundaries. See CTD.

Cell Transfer Delay (CTD) - This is defined as the elapsed time between a cell exit event at the measurement point 1 (e.g., at the source UNI) and the corresponding cell entry event at the measurement point 2 (e.g., the destination UNI) for a particular connection. The cell transfer delay between two measurement points is the sum of the total inter-ATM node transmission delay and the total ATM node processing delay.

Channel - A path or circuit along which information flows.

Channel Associated Signaling (CAS) - a form of circuit state signaling in which the circuit state is indicated by one or more bits of signaling status sent repetitively and associated with that specific circuit.

Channel Bank - A device that multiplexes many slow speed voice or data conversations onto high speed link and controls the flow.

Channel Service Unit (CSU) - An interface for digital leased lines which performs loopback testing and line conditioning.

Channelization - capability of transmitting independent signals together over a cable while still maintaining their separate identity for later separation.

Circuit - A communications link between points.

Circuit Emulation Service (CES) - The ATM Forum circuit emulation service interoperability specification specifies interoperability agreements for supporting Constant Bit Rate (CBR) traffic over ATM networks that comply with the other ATM Forum interoperability agreements. Specifically, this specification supports emulation of existing TDM circuits over ATM networks.

Classical IP (CLIP) - IP over ATM which conforms to RFC 1577.

Clear to Send (CTS) - and RS-232 modem interface control signal (sent from the modem to the DTE on pin 5) which indicates that the attached DTE may begin transmitting; issuance in response to the DTE's RTS.

Clocking - Regularly timed impulses.

Closed User Group - A subgroup of network users that can be its own entity; any member of the subgroup can only communicate with other members of that subgroup.

Coaxial Cable - Coax is a type of electrical communications medium used in the LAN environment. This cable consists of an outer conductor concentric to an inner conductor, separated from each other by insulating material, and covered by some protective outer material. This medium offers large bandwidth, supporting high data rates with high immunity to electrical interference and a low incidence of errors. Coax is subject to distance limitations and is relatively expensive and difficult to install.

Cold Start Trap - an SNMP trap which is sent after a power-cycle (see *trap*).

Collision - Overlapping transmissions that occur when two or more nodes on a LAN attempt to transmit at or about the same time.

Committed Information Rate (CIR) - CIR is the information transfer rate which a network offering Frame Relay Services (FRS) is committed to transfer under normal conditions. The rate is averaged over a minimum increment of time.

Common Channel Signaling (CCS) - A form signaling in which a group of circuits share a signaling channel. Refer to SS7.

Common Management Interface Protocol (CMIP) - An ITU-TSS standard for the message formats and procedures used to exchange management information in order to operate, administer maintain and provision a network.

Concatenation - The connection of transmission channels similar to a chain.

Concentrator - a communications device that offers the ability to concentrate many lower-speed channels into and out of one or more high-speed channels.

Configuration - The phase in which the LE Client discovers the LE Service.

Congestion Management - traffic management feature that helps ensure reasonable service for VBR connections in an ATM network, based on a priority, sustained cell rate (SCR), and peak cell rate (PCR). During times of congestion, bandwidth is reduced to the SCR, based on the priority of the connection.

Connection - the concatenation of ATM Layer links in order to provide an end-to-end information transfer capability to access points.

Connection Admission Control (CAC) - the procedure used to decide if a request for an ATM connection can be accepted based on the attributes of both the requested connection and the existing connections.

Connection Endpoint (CE) - a terminator at one end of a layer connection within a SAP.

Connection Endpoint Identifier (CEI) - an identifier of a CE that can be used to identify the connection at a SAP.

Connectionless Broadband Data Service (CBDS) - A connectionless service similar to Bellcore's SMDS defined by European Telecommunications Standards Institute (ETSI).

Connectionless Service - a type of service in which no pre-determined path or link has been established for transfer of information, supported by AAL 4.

Connectionless Service (CLS) - A service which allows the transfer of information among service subscribers without the need for end-to- end establishment procedures.

Connection-Oriented Service - a type of service in which information always traverses the same pre-established path or link between two points, supported by AAL 3.

Constant Bit Rate (CBR) - a type of traffic that requires a continuous, specific amount of bandwidth over the ATM network (e.g., digital information such as video and digitized voice).

Controlled Slip (CS) - a situation in which one frame's worth of data is either lost or replicated. A controlled slip typically occurs when the sending device and receiving device are not using the same clock.

Convergence Sublayer (CS) - a portion of the AAL. Data is passed first to the CS where it is divided into rational, fixed-length packets or PDUs (Protocol Data Units). For example, AAL 4 processes user data into blocks that are a maximum of 64 kbytes long.

Corresponding Entities - peer entities with a lower layer connection among them.

cpath - a FORE program used to manage virtual paths on a *ForeRunner* switch running asxd.

cport - a FORE program that monitors and changes the state of ports on a *ForeRunner* switch running asxd.

Cross Connection - a mapping between two channels or paths at a network device.

Customer Premise Equipment (CPE) - equipment that is on the customer side of the point of demarcation, as opposed to equipment that is on a carrier side. See also point of demarcation.

Cut Through - Establishment of a complete path for signaling and/or audio communications.

Cyclic Redundancy Check (CRC) - an error detection scheme in which a number is derived from the data that will be transmitted. By recalculating the CRC at the remote end and comparing it to the value originally transmitted, the receiving node can detect errors.

D3/D4 - Refers to compliance with AT&T TR (Technical Reference) 62411 definitions for coding, supervision, and alarm support. D3/D4 compatibility ensures support of digital PBXes, M24 services, Megacom services, and Mode 3 D3/D4 channel banks at DS-1 level.

D4 Channelization - refers to compliance with AT&T Technical Reference 62411 regarding DS1 frame layout (the sequential assignment of channels and time slot numbers within the DS1).

D4 Framed/Framing Format - in T1, a 193-bit frame format in which the 193rd bit is used for framing and signaling information (the frame/framing bit). To be considered in support of D4 Framing, a device must be able to synchronize and frame-up on the 193rd bit.

Data Communications Equipment (DCE) - a definition in the RS232C standard that describes the functions of the signals and the physical characteristics of an interface for a communication device such as a modem.

Data Country Code (DCC) - This specifies the country in which an address is registered. The codes are given in ISO 3166. The length of this field is two octets. The digits of the data country code are encoded in Binary Coded Decimal (BCD) syntax. The codes will be left justified and padded on the right with the hexadecimal value “F” to fill the two octets.

Data Link - Communications connection used to transmit data from a source to a destination.

Data Link Connection Identifier (DLCI) - connection identifier associated with frame relay packets that serves the same functions as, and translates directly to, the VPI/VCI on an ATM cell.

Data Link Layer - Layer 2 of the OSI model, responsible for encoding data and passing it to the physical medium. The IEEE divides this layer into the LLC (Logical Link Control) and MAC (Media Access Control) sublayers.

Data Set Ready (DSR) - an RS-232 modem interface control signal (sent from the modem to the DTE on pin 6) which indicates that the modem is connected to the telephone circuit. Usually a prerequisite to the DTE issuing RTS.

Data Terminal Equipment (DTE) - generally user devices, such as terminals and computers, that connect to data circuit-terminating equipment. They either generate or receive the data carried by the network.

Data Terminal Ready (DTR) - an RS232 modem interface control signal (sent from the DTE to the modem on pin 20) which indicates that the DTE is ready for data transmission and which requests that the modem be connected to the telephone circuit.

Datagram - a packet of information used in a connectionless network service that is routed to its destination using an address included in the datagram's header.

DECnet - Digital Equipment Corporation's proprietary LAN.

Defense Advanced Research Projects Agency (DARPA) - the US government agency that funded the ARPANET.

Demultiplexing - a function performed by a layer entity that identifies and separates SDUs from a single connection to more than one connection (see *multiplexing*).

Destination End Station (DES) - An ATM termination point which is the destination for ATM messages of a connection and is used as a reference point for ABR services. See SES.

Digital Access and Cross-Connect System (DACS) - Digital switching system for routing T1 lines, and DS-0 portions of lines, among multiple T1 ports.

Digital Cross-connect System (DCS) - an electronic patch panel used to route digital signals in a central office.

Digital Standard n (0, 1, 1C, 2, and 3) (DSn) - a method defining the rate and format of digital hierarchy, with asynchronous data rates defined as follows:

DS0	64kb/s	1 voice channel
DS1	1.544Mb/s	24 DS0s
DS1C	3.152 Mb/s	2 DS1s
DS2	6.312 Mb/s	4 DS1s
DS3	44.736 Mb/s	28 DS1s

Synchronous data rates (SONET) are defined as:

STS-1/OC-1	51.84 Mb/s	28 DS1s or 1 DS3
STS-3/OC-3	155.52 Mb/s	3 STS-1s byte interleaved
STS-3c/OC-3c	155.52 Mb/s	Concatenated, indivisible payload
STS-12/OC-12	622.08 Mb/s	12 STS-1s, 4 STS-3cs, or any mixture
STS-12c/OC-12c	622.08 Mb/s	Concatenated, indivisible payload
STS-48/OC-48	2488.32 Mb/s	48 STS-1s, 16 STS-3cs, or any mixture

DIP (Dual In-line Package) Switch - a device that has two parallel rows of contacts that let the user switch electrical current through a pair of those contacts to on or off. They are used to reconfigure components and peripherals.

Domain Name Server - a computer that converts names to their corresponding Internet numbers. It allows users to telnet or FTP to the name instead of the number.

Domain Naming System (DNS) - the distributed name and address mechanism used in the Internet.

Duplex - Two way communication.

DXI - a generic phrase used in the full names of several protocols, all commonly used to allow a pair of DCE and DTE devices to share the implementation of a particular WAN protocol. The protocols define the packet formats used to transport data between DCE and DTE devices.

DXI Frame Address (DFA) - a connection identifier associated with ATM DXI packets that serves the same functions as, and translates directly to, the VPI/VCI on an ATM cell.

Dynamic Allocation - A technique in which the resources assigned for program execution are determined by criteria applied at the moment of need.

E.164 - A public network addressing standard utilizing up to a maximum of 15 digits. ATM uses E.164 addressing for public network addressing.

E1 - Wide-area digital transmission scheme used predominantly in Europe that carries data at a rate of 2.048 Mbps. E1 lines can be leased for private use from common carriers.

E3 - Wide-area digital transmission scheme used predominantly in Europe that carries data at a rate of 34.368 Mbps. E3 lines can be leased for private use from common carriers.

Edge Device - A physical device which is capable of forwarding packets between legacy interworking interfaces (e.g., Ethernet, Token Ring, etc.) and ATM interfaces based on data-link and network layer information but which does not participate in the running of any network layer routing protocol. An Edge Device obtains forwarding descriptions using the route distribution protocol.

elarp - a FORE program that shows and manipulates MAC and ATM address mappings for LAN Emulation Clients (LECs).

elconfig - a FORE program that shows and modifies LEC configuration. Lets the user set the NSAP address of the LAN Emulation Configuration Server, display the list of Emulated LANs configured in the LECS for this host, display the list of ELANs locally configured along with the membership state of each, and locally administer ELAN membership.

Electrically Erasable Programmable Read Only Memory (EEPROM) - an EPROM that can be cleared with electrical signals rather than the traditional ultraviolet light.

Electromagnetic Interference (EMI) - signals generated and radiated by an electronic device that cause interference with radio communications, among other effects.

Electronics Industries Association (EIA) - a USA trade organization that issues its own standards and contributes to ANSI; developed RS-232. Membership includes USA manufacturers.

Embedded SNMP Agent - an SNMP agent can come in two forms: embedded or proxy. An embedded SNMP agent is integrated into the physical hardware and software of the unit.

Emulated Local Area Network (ELAN) - A logical network initiated by using the mechanisms defined by LAN Emulation. This could include ATM and legacy attached end stations.

End System (ES) - a system where an ATM connection is terminated or initiated (an originating end system initiates the connection; a terminating end system terminates the connection).

End System Identifier (ESI) - This identifier distinguishes multiple nodes at the same level in case the lower level peer group is partitioned.

End-to-End Connection - when used in reference to an ATM network, a connection that travels through an ATM network, passing through various ATM devices and with endpoints at the termination of the ATM network.

Enterprise - Terminology generally referring to customers with multiple, non-contiguous geographic locations.

Equalization (EQL) - the process of compensating for line distortions.

Erasable Programmable Read Only Memory (EPROM) - A PROM which may be erased and rewritten to perform new or different functions (normally done with a PROM burner).

Errored Second (ES) - a second during which at least one code violation occurred.

Ethernet - a 10-Mbps, coaxial standard for LANs in which all nodes connect to the cable where they contend for access.

Excessive Zeroes (EXZ) Error Event - An Excessive Zeroes error event for an AMI-coded signal is the occurrence of more than fifteen contiguous zeroes. For a B8ZS coded signal, the defect occurs when more than seven contiguous zeroes are detected.

Explicit Forward Congestion Indication (EFCI) - the second bit of the payload type field in the header of an ATM cell, the EFCI bit indicates network congestion to receiving hosts. On a congested switch, the EFCI bit is set to “1” by the transmitting network module when a certain number of cells have accumulated in the network module's shared memory buffer. When a cell is received that has its EFCI bit set to “1,” the receiving host notifies the sending host, which should then reduce its transmission rate.

Explicit Rate (ER) - The Explicit Rate is an RM-cell field used to limit the source ACR to a specific value. It is initially set by the source to a requested rate (such as PCR). It may be subsequently reduced by any network element in the path to a value that the element can sustain. ER is formatted as a rate.

Extended Industry Standard Architecture (EISA) - bus architecture for desktop computers that provides a 32-bit data passage and maintains compatibility with the ISA or AT architecture.

Extended Super Frame (ESF) - a T1 framing format that utilizes the 193rd bit as a framing bit, but whose Superframe is made up of 24 frames instead of 12 as in D4 format. ESF also provides CRC error detection and maintenance data link functions.

Exterior Gateway Protocol (EGP) - used by gateways in an internet, connecting autonomous networks.

Fairness - related to Generic Flow Control, fairness is defined as meeting all of the agreed quality of service requirements by controlling the order of service for all active connections.

Far End Block Error (FEBE) - an error detected by extracting the 4-bit FEBE field from the path status byte (G1). The legal range for the 4-bit field is between 0000 and 1000, representing zero to eight errors. Any other value is interpreted as zero errors.

Far End Receive Failure (FERF) - a line error asserted when a 110 binary pattern is detected in bits 6, 7, 8 of the K2 byte for five consecutive frames. A line FERF is removed when any pattern other than 110 is detected in these bits for five consecutive frames.

Far-End - in a relationship between two devices in a circuit, the far-end device is the one that is remote.

Face Contact (FC) - Designation for fiber optic connector designed by Nippon Telegraph and Telephone which features a movable anti-rotation key allowing good repeatable performance despite numerous mating. Normally referred to as Fiber Connector, FC actually stands for Face Contact and sometimes linked with PC (Point Contact), designated as FC or FC-PC.

FCC Part 68 - The FCC rules regulating the direct connection of non-telephone company provided equipment to the public telephone network.

Federal Communications Commission (FCC) - a board of commissioners appointed by the President under the Communications Act of 1934, with the authority to regulate all interstate telecommunications originating in the United States, including transmission over phone lines.

Fiber Distributed Data Interface (FDDI) - high-speed data network that uses fiber-optic as the physical medium. Operates in similar manner to Ethernet or Token Ring, only faster.

File Transfer Protocol (FTP) - a TCP/IP protocol that lets a user on one computer access, and transfer data to and from, another computer over a network. ftp is usually the name of the program the user invokes to accomplish this task.

First-In, First-Out (FIFO) - method of coordinating the sequential flow of data through a buffer.

Flag - a bit pattern of six binary “1”s bounded by a binary “0” at each end (forms a 0111 1110 or Hex “7E”). It is used to mark the beginning and/or end of a frame.

Flow Control - The way in which information is controlled in a network to prevent loss of data when the receiving buffer is near its capacity.

***ForeThought* PNNI (FT-PNNI) -** a FORE Systems routing and signalling protocol that uses private ATM (NSAP) addresses; a precursor to ATM Forum PNNI (see PNNI).

Forward Error Correction (FEC) - A technique used by a receiver for correcting errors incurred in transmission over a communications channel without requiring retransmission of any information by the transmitter; typically involves a convolution of the transmitted bits and the appending of extra bits by both the receiver and transmitter using a common algorithm.

Forward Explicit Congestion Notification (FECN) - Bit set by a Frame Relay network to inform data terminal equipment (DTE) receiving the frame that congestion was experienced in the path from source to destination. DTE receiving frames with the FECN bit set can request that higher-level protocols take flow control action as appropriate.

Fractional T1 - the use of bandwidth in 64Kbps increments up to 1.544Mbps from a T1 facility.

Frame - a variable length group of data bits with a specific format containing flags at the beginning and end to provide demarcation.

Frame Check Sequence (FCS) - In bit-oriented protocols, a 16-bit field that contains transmission error checking information, usually appended to the end of the frame.

Frame Relay - a fast packet switching protocol based on the LAPD protocol of ISDN that performs routing and transfer with less overhead processing than X.25.

Frame Synchronization Error - an error in which one or more time slot framing bits are in error.

Frame-Based UNI (FUNI) - An ATM switch-based interface which accepts frame-based ATM traffic and converts it into cells.

Frame-Relay Service (FRS) - A connection oriented service that is capable of carrying up to 4096 bytes per frame.

Framing - a protocol that separates incoming bits into identifiable groups so that the receiving multiplexer recognizes the grouping.

Frequency Division Multiplexing (FDM) - a method of dividing an available frequency range into parts with each having enough bandwidth to carry one channel.

Gbps - gigabits per second (billion)

Generic Cell Rate Algorithm (GCRA) - an algorithm which is employed in traffic policing and is part of the user/network service contract. The GCRA is a scheduling algorithm which ensures that cells are marked as conforming when they arrive when expected or later than expected and non-conforming when they arrive sooner than expected.

Generic Connection Admission Control (GCAC) - This is a process to determine if a link has potentially enough resources to support a connection.

Generic Flow Control (GFC) - the first four bits of the first byte in an ATM cell header. Used to control the flow of traffic across the User-to-Network Interface (UNI), and thus into the network. Exact mechanisms for flow control are still under investigation and no explicit definition for this field exists at this time. (This field is used only at the UNI; for NNI-NNI use (between network nodes), these four bits provide additional network address capacity, and are appended to the VPI field.)

GIO - a proprietary bus architecture used in certain Silicon Graphics, Inc. workstations.

Header - protocol control information located at the beginning of a protocol data unit.

Header Error Control (HEC) - a CRC code located in the last byte of an ATM cell header that is used for checking cell header integrity only.

High Density Bipolar (HDB3) - A bipolar coding method that does not allow more than 3 consecutive zeroes.

High Level Data Link Control (HDLC) - An ITU-TSS link layer protocol standard for point-to-point and multi-point communications.

High Performance Parallel Interface (HIPPI) - ANSI standard that extends the computer bus over fairly short distances at speeds of 800 and 1600 Mbps.

High-Speed Serial Interface (HSSI) - a serial communications connection that operates at speeds of up to 1.544 Mbps.

Host - In a network, the primary or controlling computer in a multiple computer installation.

HPUX - the Hewlett-Packard version of UNIX.

Hub - a device that connects several other devices, usually in a star topology.

I/O Module - FORE's interface cards for the LAX-20 LAN Access Switch, designed to connect Ethernet, Token Ring, and FDDI LANs to *ForeRunner* ATM networks.

Institute of Electrical and Electronics Engineers (IEEE) - the world's largest technical professional society. Based in the U.S., the IEEE sponsors technical conferences, symposia & local meetings worldwide, publishes nearly 25% of the world's technical papers in electrical, electronics & computer engineering, provides educational programs for members, and promotes standardization.

IEEE 802 - Standards for the interconnection of LAN computer equipment. Deals with the Data Link Layers of the ISO Reference Model for OSI.
IEEE 802.1 - Defines the high-level network interfaces such as architecture, internetworking and network management.
IEEE 802.2 - Defines the Logical Link Control interface between the Data Link and Network Layers.
IEEE 802.3 - Defines CSMA/CD (Ethernet).
IEEE 802.4 - Defines the token-passing bus.
IEEE 802.5 - Defines the Token Ring access methodology. This standard incorporates IBM's Token Ring specifications.
IEEE 802.6 - Defines Metropolitan Area Networks.
IEEE 802.7 - The broadband technical advisory group.
IEEE 802.8 - The fiber optics technical advisory group.
IEEE 802.9 - Defines integrated data and voice networks.

Integrated Services Digital Network (ISDN) - an emerging technology that is beginning to be offered by the telephone carriers of the world. ISDN combines voice and digital network services into a single medium or wire.

Interexchange Carriers (IXC) - Long-distance communications companies that provide service between Local Access Transport Areas (LATAs).

Interface Data - the unit of information transferred to/from the upper layer in a single interaction across a SAP. Each Interface Data Unit (IDU) controls interface information and may also contain the whole or part of the SDU.

Interface Data Unit (IDU) - The unit of information transferred to/from the upper layer in a single interaction across the SAP. Each IDU contains interface control information and may also contain the whole or part of the SDU.

Interim Local Management Interface (ILMI) - the standard that specifies the use of the Simple Network Management Protocol (SNMP) and an ATM management information base (MIB) to provide network status and configuration information.

Intermediate System (IS) - a system that provides forwarding functions or relaying functions or both for a specific ATM connection. OAM cells may be generated and received.

International Standards Organization (ISO) - a voluntary, non treaty organization founded in 1946 that is responsible for creating international standards in many areas, including computers and communications.

International Telephone and Telegraph Consultative Committee (CCITT) - the international standards body for telecommunications.

Internet - (note the capital “I”) the largest internet in the world including large national backbone nets and many regional and local networks worldwide. The Internet uses the TCP/IP suite. Networks with only e-mail connectivity are not considered on the Internet.

internet - while an internet is a network, the term “internet” is usually used to refer to a collection of networks interconnected with routers.

Internet Addresses - the numbers used to identify hosts on an internet network. Internet host numbers are divided into two parts; the first is the network number and the second, or local, part is a host number on that particular network. There are also three classes of networks in the Internet, based on the number of hosts on a given network. Large networks are classified as Class A, having addresses in the range 1-126 and having a maximum of 16,387,064 hosts. Medium networks are classified as Class B, with addresses in the range 128-191 and with a maximum of 64,516 hosts. Small networks are classified as Class C, having addresses in the range 192-254 with a maximum of 254 hosts. Addresses are given as dotted decimal numbers in the following format:

nnn.nnn.nnn.nnn

In a Class A network, the first of the numbers is the network number, the last three numbers are the local host address.

In a Class B network, the first two numbers are the network, the last two are the local host address.

In a Class C network, the first three numbers are the network address, the last number is the local host address.

The following table summarizes the classes and sizes:

Class	First #	Max# Hosts
A	1-126	16,387,064
B	129-191	64,516
C	192-223	254

Network mask values are used to identify the network portion and the host portion of the address. Default network masks are as follows:

Class A - 255.0.0.0

Class B - 255.255.0.0

Class C - 255.255.255.0

Subnet masking is used when a portion of the host ID is used to identify a subnetwork. For example, if a portion of a Class B network address is used for a subnetwork, the mask could be set as 255.255.255.0. This would allow the third byte to be used as a subnetwork address. All hosts on the network would still use the IP address to get on the Internet.

Internet Control Message Protocol (ICMP) - the protocol that handles errors and control messages at the IP layer. ICMP is actually a part of the IP protocol layer. It can generate error messages, test packets, and informational messages related to IP.

Internet Engineering Task Force (IETF) - a large, open, international community of network designers, operators, vendors and researchers whose purpose is to coordinate the operation, management and evolution of the Internet to resolve short- and mid-range protocol and architectural issues.

Internet Protocol (IP) - a connectionless, best-effort packet switching protocol that offers a common layer over dissimilar networks.

Internetwork Packet Exchange (IPX) Protocol - a NetWare protocol similar to the Xerox Network Systems (XNS) protocol that provides datagram delivery of messages.

Interoperability - The ability of software and hardware on multiple machines, from multiple vendors, to communicate.

Interworking Function (IWF) - provides a means for two different technologies to interoperate.

IP Address - a unique 32-bit integer used to identify a device in an IP network. You will most commonly see IP addresses written in “dot” notation (e.g., 192.228.32.14).

IP Netmask - a 32-bit pattern that is combined with an IP address to determine which bits of an IP address denote the network number and which denote the host number. Netmasks are useful for sub-dividing IP networks. IP netmasks are written in “dot” notation (e.g., 255.255.0.0).

ISA Bus - a bus standard developed by IBM for expansion cards in the first IBM PC. The original bus supported a data path only 8 bits wide. IBM subsequently developed a 16-bit version for its AT class computers. The 16-bit AT ISA bus supports both 8- and 16-bit cards. The 8-bit bus is commonly called the PC/XT bus, and the 16-bit bus is called the AT bus.

Isochronous - signals carrying embedded timing information or signals that are dependent on uniform timing; usually associated with voice and/or video transmission.

International Telecommunications Union Telecommunications (ITU-T) - an international body of member countries whose task is to define recommendations and standards relating to the international telecommunications industry. The fundamental standards for ATM have been defined and published by the ITU-T (Previously CCITT).

J2 - Wide-area digital transmission scheme used predominantly in Japan that carries data at a rate of 6.312 Mbps.

Jitter - analog communication line distortion caused by variations of a signal from its reference timing position.

Joint Photographic Experts Group (JPEG) - An ISO Standards group that defines how to compress still pictures.

Jumper - a patch cable or wire used to establish a circuit, often temporarily, for testing or diagnostics; also, the devices, shorting blocks, used to connect adjacent exposed pins on a printed circuit board that control the functionality of the card.

Kbps - kilobits per second (thousand)

LAN Access Concentrator - a LAN access device that allows a shared transmission medium to accommodate more data sources than there are channels currently available within the transmission medium.

LAN Emulation Address Resolution Protocol (LE_ARP) - A message issued by a LE client to solicit the ATM address of another function.

LAN Emulation Client (LEC) - the component in an end system that performs data forwarding, address resolution, and other control functions when communicating with other components within an ELAN.

LAN Emulation Configuration Server (LECS) - the LECS is responsible for the initial configuration of LECs. It provides information about available ELANs that a LEC may join, together with the addresses of the LES and BUS associated with each ELAN.

LAN Emulation Server (LES) - the LES implements the control coordination function for an ELAN by registering and resolving MAC addresses to ATM addresses.

LAN Emulation (LANE) - technology that allows an ATM network to function as a LAN backbone. The ATM network must provide multicast and broadcast support, address mapping (MAC-to-ATM), SVC management, and a usable packet format. LANE also defines Ethernet and Token Ring ELANs.

lane - a program that provides control over the execution of the LAN Emulation Server (LES), Broadcast/Unknown Server (BUS), and LAN Emulation Configuration Server (LECS) on the local host.

Latency - The time interval between a network station seeking access to a transmission channel and that access being granted or received.

Layer Entity - an active layer within an element.

Layer Function - a part of the activity of the layer entities.

Layer Service - a capability of a layer and the layers beneath it that is provided to the upper layer entities at the boundary between that layer and the next higher layer.

Layer User Data - the information transferred between corresponding entities on behalf of the upper layer or layer management entities for which they are providing services.

le - a FORE program that implements both the LAN Emulation Server (LES) and the Broadcast/Unknown Server (BUS).

Leaky Bucket - informal cell policing term for the Generic Cell Rate Algorithm which in effect receives cells into a bucket and leaks them out at the specified or contracted rate (i.e., PCR).

Least Significant Bit (LSB) - lowest order bit in the binary representation of a numerical value.

lecs - a FORE program that implements the assignment of individual LECs to different emulated LANs.

leq - a FORE program that provides information about an ELAN. This information is obtained from the LES, and includes MAC addresses registered on the ELAN together with their corresponding ATM addresses.

Line Build Out (LBO) - Because T1 circuits require the last span to lose 15-22.5 dB, a selectable output attenuation is generally required of DTE equipment (typical selections include 0.0, 7.5 and 15 dB of loss at 772 KHz).

Line Code Violations (LCV) - Error Event. A Line Coding Violation (LCV) is the occurrence of either a Bipolar Violation (BPV) or Excessive Zeroes (EXZ) Error Event.

Link - An entity that defines a topological relationship (including available transport capacity) between two nodes in different subnetworks. Multiple links may exist between a pair of subnetworks. Synonymous with logical link.

Link Access Procedure, Balanced (LAPB) - Data link protocol in the X.25 protocol stack. LAPB is a bit-oriented protocol derived from HDLC. See also HDLC and X.25.

Link Down Trap - an SNMP trap, sent when an interface changes from a normal state to an error state, or is disconnected.

Link Layer - layer in the OSI model regarding transmission of data between network nodes.

Link Up Trap - an SNMP trap, sent when an interface changes from an error condition to a normal state.

Load Sharing - Two or more computers in a system that share the load during peak hours. During periods of non peak hours, one computer can manage the entire load with the other acting as a backup.

Local Access and Transport Area (LATA) - Geographic boundaries of the local telephone network, specified by the FCC, in which a single LEC may perform its operations. Communications outside or between LATAs are provided by IXCs.

Local Area Network (LAN) - a data network intended to serve an area of only a few square kilometers or less. Because the network is known to cover only a small area, optimizations can be made in the network signal protocols that permit higher data rates.

Logical Link Control (LLC) - protocol developed by the IEEE 802 committee for data-link-layer transmission control; the upper sublayer of the IEEE Layer 2 (OSI) protocol that complements the MAC protocol; IEEE standard 802.2; includes end-system addressing and error checking.

Loopback - a troubleshooting technique that returns a transmitted signal to its source so that the signal can be analyzed for errors. Typically, a loopback is set at various points in a line until the section of the line that is causing the problem is discovered.

looptest - program that tests an interface for basic cell reception and transmission functionality, usually used for diagnostic purposes to determine if an interface is functioning properly.

Loss Of Frame (LOF) - a type of transmission error that may occur in wide-area carrier lines.

Loss Of Pointer (LOP) - a type of transmission error that may occur in wide-area carrier lines.

Loss Of Signal (LOS) - a type of transmission error that may occur in wide-area carrier lines, or a condition declared when the DTE senses a loss of a DS1 signal from the CPE for more the 150 milliseconds (the DTE generally responds with an all ones “Blue or AIS” signal).

Management Information Base (MIB) - the set of parameters that an SNMP management station can query or set in the SNMP agent of a networked device (e.g., router).

Maximum Burst Size (MBS) - the Burst Tolerance (BT) is conveyed through the MBS which is coded as a number of cells. The BT together with the SCR and the GCRA determine the MBS that may be transmitted at the peak rate and still be in conformance with the GCRA.

Maximum Burst Tolerance - the largest burst of data that a network device is guaranteed to handle without discarding cells or packets. Bursts of data larger than the maximum burst size may be subject to discard.

Maximum Cell Delay Variance (MCDV) - This is the maximum two-point CDV objective across a link or node for the specified service category.

Maximum Cell Loss Ratio (MCLR) - This is the maximum ratio of the number of cells that do not make it across the link or node to the total number of cells arriving at the link or node.

Maximum Cell Transfer Delay (MCTD) - This is the sum of the fixed delay component across the link or node and MCDV.

Maximum Transmission Unit (MTU) - the largest unit of data that can be sent over a type of physical medium.

Mbps - megabits per second (million)

Media Access Control (MAC) - a media-specific access control protocol within IEEE 802 specifications; currently includes variations for Token Ring, token bus, and CSMA/CD; the lower sublayer of the IEEE’s link layer (OSI), which complements the Logical Link Control (LLC).

Media Attachment Unit (MAU) - device used in Ethernet and IEEE 802.3 networks that provides the interface between the AUI port of a station and the common medium of the Ethernet. The MAU, which can be built into a station or can be a separate device, performs physical layer functions including conversion of the digital data from the Ethernet interface, collision detection, and injection of bits onto the network.

Media Interface Connector (MIC) - fiber optic connector that joins fiber to the FDDI controller.

Message Identifier (MID) - message identifier used to associate ATM cells that carry segments from the same higher layer packet.

Metasignalling - an ATM Layer Management (LM) process that manages different types of signalling and possibly semipermanent virtual channels (VCs), including the assignment, removal, and checking of VCs.

Metasignalling VCs - the standardized VCs that convey metasignalling information across a User-to-Network Interface (UNI).

Metropolitan Area Network (MAN) - network designed to carry data over an area larger than a campus such as an entire city and its outlying area.

MicroChannel - a proprietary 16- or 32-bit bus developed by IBM for its PS/2 computers' internal expansion cards; also offered by others.

Minimum Cell Rate (MCR) - parameter defined by the ATM Forum for ATM traffic management, defined only for ABR transmissions and specifying the minimum value for the ACR.

Most Significant Bit (MSB) - highest order bit in the binary representation of a numerical value.

Motion Picture Experts Group (MPEG) - ISO group dealing with video and audio compression techniques and mechanisms for multiplexing and synchronizing various media streams.

MPOA Client - A device which implements the client side of one or more of the MPOA protocols, (i.e., is a SCP client and/or an RDP client. An MPOA Client is either an Edge Device Functional Group (EDFG) or a Host Behavior Functional Group (HBFG).

MPOA Server - An MPOA Server is any one of an ICFG or RSFG.

MPOA Service Area - The collection of server functions and their clients. A collection of physical devices consisting of an MPOA server plus the set of clients served by that server.

MPOA Target - A set of protocol address, path attributes, (e.g., internetwork layer QoS, other information derivable from received packet) describing the intended destination and its path attributes that MPOA devices may use as lookup keys.

Mu-Law - The PCM coding and companding standard used in Japan and North America.

Multicasting - The ability to broadcast messages to one node or a select group of nodes.

Multi-homed - a device having both an ATM and another network connection, like Ethernet.

Multimode Fiber Optic Cable (MMF) - fiber optic cable in which the signal or light propagates in multiple modes or paths. Since these paths may have varying lengths, a transmitted pulse of light may be received at different times and smeared to the point that pulses may interfere with surrounding pulses. This may cause the signal to be difficult or impossible to receive. This pulse dispersion sometimes limits the distance over which a MMF link can operate.

Multiplexing - a function within a layer that interleaves the information from multiple connections into one connection (see demultiplexing).

Multipoint Access - user access in which more than one terminal equipment (TE) is supported by a single network termination.

Multipoint-to-Multipoint Connection - a collection of associated ATM VC or VP links, and their associated endpoint nodes, with the following properties:

1. All N nodes in the connection, called Endpoints, serve as a Root Node in a Point-to-Multipoint connection to all of the (N-1) remaining endpoints.

2. Each of the endpoints can send information directly to any other endpoint, but the receiving endpoint cannot distinguish which of the endpoints is sending information without additional (e.g., higher layer) information.

Multipoint-to-Point Connection - a Point-to-Multipoint Connection may have zero bandwidth from the Root Node to the Leaf Nodes, and non-zero return bandwidth from the Leaf Nodes to the Root Node. Such a connection is also known as a Multipoint-to-Point Connection.

Multiprotocol over ATM (MPOA) - An effort taking place in the ATM Forum to standardize protocols for the purpose of running multiple network layer protocols over ATM.

Narrowband Channel - sub-voicegrade channel with a speed range of 100 to 200 bps.

National TV Standards Committee (NTSC) - Started in the US in 1953 from a specification laid down by the National Television Standards Committee. It takes the B-Y and R-Y color difference signals, attenuates them to I and Q, then modulates them using double-sideband suppressed subcarrier at 3.58MHz. The carrier reference is sent to the receiver as a burst during the back porch. An industry group that defines how television signals are encoded and transmitted in the US. (See also PAL, SECAM for non-U.S. countries).

Near-End - in a relationship between two devices in a circuit, the near-end device is the one that is local.

Network Layer - Layer three In the OSI model, the layer that is responsible for routing data across the network.

Network Management Entity (NM) - body of software in a switching system that provides the ability to manage the PNNI protocol. NM interacts with the PNNI protocol through the MIB.

Network Management Layer (NML) - an abstraction of the functions provided by systems which manage network elements on a collective basis, providing end-to-end network monitoring.

Network Management Station (NMS) - system responsible for managing a network or portion of a network by talking to network management agents, which reside in the managed nodes.

Network Module - ATM port interface cards which may be individually added to or removed from any *ForeRunner* ATM switch to provide a diverse choice of connection alternatives.

Network Parameter Control (NPC) - Defined as the set of actions taken by the network to monitor and control traffic from the NNI. Its main purpose is to protect network resources from malicious as well as unintentional misbehavior which can affect the QoS of other already established connections by detecting violations of negotiated parameters and taking appropriate actions. Refer to UPC.

Network Redundancy - Duplicated network equipment and/or data which can provide a backup in case of network failures.

Network Service Access Point (NSAP) - OSI generic standard for a network address consisting of 20 octets. ATM has specified E.164 for public network addressing and the NSAP address structure for private network addresses.

Network-to-Network Interface or Network Node Interface (NNI) - the interface between two public network pieces of equipment.

Node - A computer or other device when considered as part of a network.

Non Return to Zero (NRZ) - a binary encoding scheme in which ones and zeroes are represented by opposite and alternating high and low voltages and where there is no return to a zero (reference) voltage between encoded bits.

Non Return to Zero Inverted (NRZI) - A binary encoding scheme that inverts the signal on a “1” and leaves the signal unchanged for a “0”. (Also called transition encoding.)

Nonvolatile Storage - Memory storage that does not lose its contents when power is turned off.

NuBus - a high-speed bus used in Macintosh computers, structured so users can put a card into any slot on the board without creating conflict over the priority between those cards.

nx64K - This refers to a circuit bandwidth or speed provided by the aggregation of nx64 kbps channels (where n= integer > 1). The 64K or DS0 channel is the basic rate provided by the T Carrier systems.

Nyquist Theorem - In communications theory, a formula stating that two samples per cycle is sufficient to characterize a bandwidth limited analog signal; in other words, the sampling rate must be twice the highest frequency component of the signal (i.e., sample 4 KHz analog voice channels 8000 times per second).

Object Identifier (OID) - the address of a MIB variable.

Octet - a grouping of 8 bits; similar, but not identical to, a byte.

One’s Density - The requirement for digital transmission lines in the public switched telephone network that eight consecutive “0”s cannot be in a digital data stream; exists because repeaters and clocking devices within the network will lose timing after receiving eight “0”s in a row; a number of techniques are used to insert a “1” after every seventh-consecutive “0” (see Bit Stuffing).

Open Shortest Path First (OSPF) Protocol - a routing algorithm for IP that incorporates least-cost, equal-cost, and load balancing.

Open Systems Interconnection (OSI) - the 7-layer suite of protocols designed by ISO committees to be the international standard computer network architecture.

OpenView - Hewlett-Packard's network management software.

Operation and Maintenance (OAM) Cell - a cell that contains ATM LM information. It does not form part of the upper layer information transfer.

Optical Carrier level-n (OC-n) - The optical counterpart of STS-n (the basic rate of 51.84 Mbps on which SONET is based is referred to as OC-1 or STS-1).

Organizationally Unique Identifier (OUI) - Part of RFC 1483. A three-octet field in the SubNetwork Attachment Point (SNAP) header, identifying an organization which administers the meaning of the following two octet Protocol Identifier (PID) field in the SNAP header. Together they identify a distinct routed or bridged protocol.

Out-of-Band Management - refers to switch configuration via the serial port or over Ethernet, not ATM.

Out-of-Frame (OOF) - a signal condition and alarm in which some or all framing bits are lost.

Packet - An arbitrary collection of data grouped and transmitted with its user identification over a shared facility.

Packet Assembler Disassembler (PAD) - interface device that buffers data sent to/from character mode devices, and assembles and disassembles the packets needed for X.25 operation.

Packet Internet Groper (ping) - a program used to test reachability of destinations by sending them an ICMP echo request and waiting for a reply.

Packet Level Protocol (PLP) - Network layer protocol in the X.25 protocol stack. Sometimes called X.25 Level 3 or X.25 Protocol.

Packet Switched Network (PSN) - a network designed to carry data in the form of packets. The packet and its format is internal to that network.

Packet Switching - a communications paradigm in which packets (messages) are individually routed between hosts with no previously established communications path.

Payload Scrambling - a technique that eliminates certain bit patterns that may occur within an ATM cell payload that could be misinterpreted by certain sensitive transmission equipment as an alarm condition.

Payload Type (PT) - bits 2...4 in the fourth byte of an ATM cell header. The PT indicates the type of information carried by the cell. At this time, values 0...3 are used to identify various types of user data, values 4 and 5 indicate management information, and values 6 and 7 are reserved for future use.

Peak Cell Rate - at the PHY Layer SAP of a point-to-point VCC, the Peak Cell Rate is the inverse of the minimum inter-arrival time T0 of the request to send an ATM-SDU.

Peak Cell Rate (PCR) - parameter defined by the ATM Forum for ATM traffic management. In CBR transmissions, PCR determines how often data samples are sent. In ABR transmissions, PCR determines the maximum value of the ACR.

Peer Entities - entities within the same layer.

Peripheral Component Interconnect (PCI) - a local-bus standard created by Intel.

Permanent Virtual Channel Connection (PVCC) - A Virtual Channel Connection (VCC) is an ATM connection where switching is performed on the VPI/VCI fields of each cell. A Permanent VCC is one which is provisioned through some network management function and left up indefinitely.

Permanent Virtual Circuit (or Channel) (PVC) - a circuit or channel through an ATM network provisioned by a carrier between two endpoints; used for dedicated long-term information transport between locations.

Permanent Virtual Path Connection (PVPC) - A Virtual Path Connection (VPC) is an ATM connection where switching is performed on the VPI field only of each cell. A PVPC is one which is provisioned through some network management function and left up indefinitely.

Phase Alternate Line (PAL) - Largely a German/British development in the late 60s, used in the UK and much of Europe. The B-Y and R-Y signals are weighted to U and V, then modulated onto a double-sideband suppressed subcarrier at 4.43MHz. The V (R-Y) signal's phase is turned through 180 degrees on each alternate line. This gets rid of NTSC's hue changes with phase errors at the expense of de-saturation. The carrier reference is sent as a burst in the back porch. The phase of the burst is alternated every line to convey the phase switching of the V signal. The burst's average phase is -V. (see NTSC for U.S.).

Physical Layer (PHY) - the actual cards, wires, and/or fiber-optic cabling used to connect computers, routers, and switches.

Physical Layer Connection - an association established by the PHY between two or more ATM-entities. A PHY connection consists of the concatenation of PHY links in order to provide an end-to-end transfer capability to PHY SAPs.

Physical Layer Convergence Protocol (PLCP) - a framing protocol that runs on top of the T1 or E1 framing protocol.

Physical Medium (PM) - Refers to the actual physical interfaces. Several interfaces are defined including STS-1, STS-3c, STS-12c, STM-1, STM-4, DS1, E1, DS2, E3, DS3, E4, FDDI-based, Fiber Channel-based, and STP. These range in speeds from 1.544Mbps through 622.08 Mbps.

Physical Medium Dependent (PMD) - a sublayer concerned with the bit transfer between two network nodes. It deals with wave shapes, timing recovery, line coding, and electro-optic conversions for fiber based links.

Plesiochronous - two signals are plesiochronous if their corresponding significant instants occur at nominally the same rate, with variations in rate constrained to specified limits.

Point of Demarcation - the dividing line between a carrier and the customer premise that is governed by strict standards that define the characteristics of the equipment on each side of the demarcation. Equipment on one side of the point of demarcation is the responsibility of the customer. Equipment on the other side of the point of demarcation is the responsibility of the carrier.

Point-to-Multipoint Connection - a collection of associated ATM VC or VP links, with associated endpoint nodes, with the following properties:

1. One ATM link, called the Root Link, serves as the root in a simple tree topology. When the Root node sends information, all of the remaining nodes on the connection, called Leaf nodes, receive copies of the information.

2. Each of the Leaf Nodes on the connection can send information directly to the Root Node. The Root Node cannot distinguish which Leaf is sending information without additional (higher layer) information. (See the following note for Phase 1.)

3. The Leaf Nodes cannot communicate directly to each other with this connection type.

Note: Phase 1 signalling does not support traffic sent from a Leaf to the Root.

Point-to-Point Connection - a connection with only two endpoints.

Point-to-Point Protocol (PPP) - Provides a method for transmitting packets over serial point-to-point links.

Policing - the function that ensures that a network device does not accept traffic that exceeds the configured bandwidth of a connection.

Port Identifier - The identifier assigned by a logical node to represent the point of attachment of a link to that node.

Presentation Layer - Sixth layer of the OSI model, providing services to the application layer.

Primary Reference Source (PRS) - Equipment that provides a timing signal whose long-term accuracy is maintained at 1 x 10 -11 or better with verification to universal coordinated time (UTC) and whose timing signal is used as the basis of reference for the control of other clocks within a network.

Primitive - an abstract, implementation-independent interaction between a layer service user and a layer service provider.

Priority - the parameter of ATM connections that determines the order in which they are reduced from the peak cell rate to the sustained cell rate in times of congestion. Connections with lower priority (4 is low, 1 is high) are reduced first.

Private Branch Exchange (PBX) - a private phone system (switch) that connects to the public telephone network and offers in-house connectivity. To reach an outside line, the user must dial a digit like 8 or 9.

Private Network Node Interface or Private Network-to-Network Interface (PNNI) - a protocol that defines the interaction of private ATM switches or groups of private ATM switches

Programmable Read-Only Memory (PROM) - a chip-based information storage area that can be recorded by an operator but erased only through a physical process.

Protocol - a set of rules and formats (semantic and syntactic) that determines the communication behavior of layer entities in the performance of the layer functions.

Protocol Control Information - the information exchanged between corresponding entities using a lower layer connection to coordinate their joint operation.

Protocol Data Unit (PDU) - a unit of data specified in a layer protocol and consisting of protocol control information and layer user data.

Proxy - the process in which one system acts for another system to answer protocol requests.

Proxy Agent - an agent that queries on behalf of the manager, used to monitor objects that are not directly manageable.

Public Data Network (PDN) - a network designed primarily for data transmission and intended for sharing by many users from many organizations.

Pulse Code Modulation (PCM) - a modulation scheme that samples the information signals and transmits a series of coded pulses to represent the data.

Q.2931 - Derived from Q.93B, the narrowband ISDN signalling protocol, an ITU standard describing the signalling protocol to be used by switched virtual circuits on ATM LANs.

Quality of Service (QoS) - Quality of Service is defined on an end-to-end basis in terms of the following attributes of the end-to-end ATM connection:

Cell Loss Ratio
Cell Transfer Delay
Cell Delay Variation

Queuing Delay (QD) - refers to the delay imposed on a cell by its having to be buffered because of unavailability of resources to pass the cell onto the next network function or element. This buffering could be a result of oversubscription of a physical link, or due to a connection of higher priority or tighter service constraints getting the resource of the physical link.

Radio Frequency Interference (RFI) - the unintentional transmission of radio signals. Computer equipment and wiring can both generate and receive RFI.

Real-Time Clock - a clock that maintains the time of day, in contrast to a clock that is used to time the electrical pulses on a circuit.

Red Alarm - In T1, a red alarm is generated for a locally detected failure such as when a condition like OOF exists for 2.5 seconds, causing a CGA, (Carrier Group Alarm).

Reduced Instruction Set Computer (RISC) - a generic name for CPUs that use a simpler instruction set than more traditional designs.

Redundancy - In a data transmission, the fragments of characters and bits that can be eliminated with no loss of information.

Registration - The address registration function is the mechanism by which Clients provide address information to the LAN Emulation Server.

Relaying - a function of a layer by means of which a layer entity receives data from a corresponding entity and transmits it to another corresponding entity.

Request To Send (RTS) - an RS-232 modem interface signal (sent from the DTE to the modem on pin 4) which indicates that the DTE has data to transmit.

Requests For Comment (RFCs) - IETF documents suggesting protocols and policies of the Internet, inviting comments as to the quality and validity of those policies. These comments are collected and analyzed by the IETF in order to finalize Internet standards.

RFC1483 - Multiprotocol Encapsulation over ATM Adaptation Layer 5.
RFC1490 - Multiprotocol Interconnect over Frame Relay.
RFC1577 - Classical IP and ARP over ATM.
RFC1755 - ATM Signaling Support for IP over ATM.

Robbed-Bit Signaling - In T1, refers to the use of the least significant bit of every word of frames 6 and 12 (D4), or 6, 12, 18, and 24 (ESF) for signaling purposes.

Route Server - A physical device that runs one or more network layer routing protocols, and which uses a route query protocol in order to provide network layer routing forwarding descriptions to clients.

Router - a device that forwards traffic between networks or subnetworks based on network layer information.

Routing Domain (RD) - A group of topologically contiguous systems which are running one instance of routing.

Routing Information Protocol (RIP) - a distance vector-based protocol that provides a measure of distance, or hops, from a transmitting workstation to a receiving workstation.

Routing Protocol - A general term indicating a protocol run between routers and/or route servers in order to exchange information used to allow computation of routes. The result of the routing computation will be one or more forwarding descriptions.

SBus - hardware interface for add-in boards in later-version Sun 3 workstations.

Scalable Processor Architecture Reduced instruction set Computer (SPARC) - a powerful workstation similar to a reduced-instruction-set-computing (RISC) workstation.

Segment - a single ATM link or group of interconnected ATM links of an ATM connection.

Segmentation And Reassembly (SAR) - the SAR accepts PDUs from the CS and divides them into very small segments (44 bytes long). If the CS-PDU is less than 44 bytes, it is padded to 44 with zeroes. A two-byte header and trailer are added to this basic segment. The header identifies the message type (beginning, end, continuation, or single) and contains sequence numbering and message identification. The trailer gives the SAR-PDU payload length, exclusive of pad, and contains a CRC check to ensure the SAR-PDU integrity. The result is a 48-byte PDU that fits into the payload field of an ATM cell.

Selector (SEL) - A subfield carried in SETUP message part of ATM endpoint address Domain specific Part (DSP) defined by ISO 10589, not used for ATM network routing, used by ATM end systems only.

Semipermanent Connection - a connection established via a service order or via network management.

Serial Line IP (SLIP) - A protocol used to run IP over serial lines, such as telephone circuits or RS-232 cables, interconnecting two systems.

Service Access Point (SAP) - the point at which an entity of a layer provides services to its LM entity or to an entity of the next higher layer.

Service Data Unit (SDU) - a unit of interface information whose identity is preserved from one end of a layer connection to the other.

Service Specific Connection Oriented Protocol (SSCOP) - an adaptation layer protocol defined in ITU-T Specification: Q.2110.

Service Specific Convergence Sublayer (SSCS) - The portion of the convergence sublayer that is dependent upon the type of traffic that is being converted.

Session Layer - Layer 5 in the OSI model that is responsible for establishing and managing sessions between the application programs running in different nodes.

Severely Errored Seconds (SES) - a second during which more event errors have occurred than the SES threshold (normally 10-3).

Shaping Descriptor - *n* ordered pairs of GCRA parameters (I,L) used to define the negotiated traffic shape of an APP connection. The traffic shape refers to the load-balancing of a network, where load-balancing means configuring data flows to maximize network efficiency.

Shielded Pair - Two insulated wires in a cable wrapped with metallic braid or foil to prevent interference and provide noise free transmission.

Shielded Twisted Pair (STP) - two or more insulated wires, twisted together and then wrapped in a cable with metallic braid or foil to prevent interference and offer noise-free transmissions.

Signaling System No. 7 (SS7) - The SS7 protocol has been specified by ITU-T and is a protocol for interexchange signaling.

Simple and Efficient Adaptation Layer (SEAL) - also called AAL 5, this ATM adaptation layer assumes that higher layer processes will provide error recovery, thereby simplifying the SAR portion of the adaptation layer. Using this AAL type packs all 48 bytes of an ATM cell information field with data. It also assumes that only one message is crossing the UNI at a time. That is, multiple end-users at one location cannot interleave messages on the same VC, but must queue them for sequential transmission.

Simple Gateway Management Protocol (SGMP) - the predecessor to SNMP.

Simple Mail Transfer Protocol (SMTP) - the Internet electronic mail protocol used to transfer electronic mail between hosts.

Simple Network Management Protocol (SNMP) - the Internet standard protocol for managing nodes on an IP network.

Simple Protocol for ATM Network Signalling (SPANS) - FORE Systems' proprietary signalling protocol used for establishing SVCs between FORE Systems equipment.

Single Mode Fiber (SMF) - Fiber optic cable in which the signal or light propagates in a single mode or path. Since all light follows the same path or travels the same distance, a transmitted pulse is not dispersed and does not interfere with adjacent pulses. SMF fibers can support longer distances and are limited mainly by the amount of attenuation. Refer to MMF.

Small Computer Systems Interface (SCSI) - a standard for a controller bus that connects hardware devices to their controllers on a computer bus, typically used in small systems.

Smart PVC (SPVC) - a generic term for any communications medium which is permanently provisioned at the end points, but switched in the middle. In ATM, there are two kinds of SPVCs: smart permanent virtual path connections (SPVPCs) and smart permanent virtual channel connections (SPVCCs).

snmpd - an SMNP agent for a given adapter card.

Source - Part of communications system which transmits information.

Source Address (SA) - The address from which the message or data originated.

Source MAC Address (SA) - A six octet value uniquely identifying an end point and which is sent in an IEEE LAN frame header to indicate source of frame.

Source Traffic Descriptor - a set of traffic parameters belonging to the ATM Traffic Descriptor used during the connection set-up to capture the intrinsic traffic characteristics of the connection requested by the source.

Spanning Tree Protocol - provides loop-free topology in a network environment where there are redundant paths.

Static Route - a route that is entered manually into the routing table.

Statistical Multiplexing - a technique for allowing multiple channels and paths to share the same link, typified by the ability to give the bandwidth of a temporarily idle channel to another channel.

Stick and Click (SC) - Designation for an Optical Connector featuring a 2.5 mm physically contacting ferrule with a push-pull mating design. Commonly referred to as Structured Cabling, Structured Connectors or Stick and Click

Stick and Turn (ST) - A fiber-optic connector designed by AT&T which uses the bayonet style coupling rather than screw-on as the SMA uses. The ST is generally considered the eventual replacement for the SMA type connector.

Store-and-Forward - the technique of receiving a message, storing it until the proper outgoing line is available, then retransmitting it, with no direct connection between incoming and outgoing lines.

Straight Tip (ST) - see *Stick and Turn*.

Structured Cabling (SC) - see *Stick and Click.*

Structured Connectors (SC) - see *Stick and Click*.

Sublayer - a logical subdivision of a layer.

SubNetwork Access Protocol (SNAP) - a specially reserved variant of IEEE 802.2 encoding SNAP indicates to look further into the packet where it will fine a Type field.

Subscriber Network Interface (SNI) - the interface between an SMDS end user's CPE and the network directly serving the end user, supported by either a DS1 or DS3 access arrangement.

Super Frame (SF) - a term used to describe the repeating 12 D4 frame format that composes a standard (non-ESF) T1 service.

Super User - a login ID that allows unlimited access to the full range of a device's functionality, including especially the ability to reconfigure the device and set passwords.

Sustainable Cell Rate (SCR) - ATM Forum parameter defined for traffic management. For VBR connections, SCR determines the long-term average cell rate that can be transmitted.

Sustained Information Rate (SIR) - In ATM this refers to the long-term average data transmission rate across the User-to-Network Interface. In SMDS this refers to the committed information rate (similar to CIR for Frame Relay Service).

Switch - Equipment used to interconnect lines and trunks.

Switched Connection - A connection established via signaling.

Switched Multimegabit Data Service (SMDS) - a high-speed, datagram-based, public data network service expected to be widely used by telephone companies in their data networks.

Switched Virtual Channel Connection (SVCC) - A Switched VCC is one which is established and taken down dynamically through control signaling. A Virtual Channel Connection (VCC) is an ATM connection where switching is performed on the VPI/VCI fields of each cell.

Switched Virtual Circuit (or Channel) (SVC) - a channel established on demand by network signalling, used for information transport between two locations and lasting only for the duration of the transfer; the datacom equivalent of a dialed telephone call.

Switched Virtual Path Connection (SVPC) - a connection which is established and taken down dynamically through control signaling. A Virtual Path Connection (VPC) is an ATM connection where switching is performed on the VPI field only of each cell.

Switching System - A set of one or more systems that act together and appear as a single switch for the purposes of PNNI routing.

Symmetric Connection - a connection with the same bandwidth specified for both directions.

Synchronous - signals that are sourced from the same timing reference and hence are identical in frequency.

Synchronous Data Link Control (SDLC) - IBM's data link protocol used in SNA networks.

Synchronous Optical Network (SONET) - a body of standards that defines all aspects of transporting and managing digital traffic over optical facilities in the public network.

Synchronous Payload Envelope (SPE) - the payload field plus a little overhead of a basic SONET signal.

Synchronous Transfer Mode (STM) - a transport and switching method that depends on information occurring in regular, fixed patterns with respect to a reference such as a frame pattern.

Synchronous Transport Signal (STS) - a SONET electrical signal rate.

Systeme En Coleur Avec Memoire (SECAM) - Sequential and Memory Color Television - Started in France in the late 60s, and used by other countries with a political affiliation. This is. The B-Y and R-Y signals are transmitted on alternate lines modulated on an FM subcarrier. The memory is a one line delay line in the receiver to make both color difference signals available at the same time on all lines. Due to FM, the signal is robust in difficult terrain.

Systems Network Architecture (SNA) - a proprietary networking architecture used by IBM and IBM-compatible mainframe computers.

T1 - a specification for a transmission line. The specification details the input and output characteristics and the bandwidth. T1 lines run at 1.544 Mbps and provide for 24 data channels. In common usage, the term “T1” is used interchangeably with “DS1.”

T1 Link - A wideband digital carrier facility used for transmission of digitized voice, digital data, and digitized image traffic. This link is composed of two twisted-wire pairs that can carry 24 digital channels, each operating at 64K bps at the aggregate rate of 1.544M bps, full duplex. Also referred to as DS-1.

T3 - a specification for a transmission line, the equivalent of 28 T1 lines. T3 lines run at 44.736 Mbps. In common usage, the term “T3” is used interchangeably with “DS3.”

Tachometer - in *ForeView*, the tachometer shows the level of activity on a given port. The number in the tachometer shows the value of a chosen parameter in percentage, with a colored bar providing a semi-logarithmic representation of that percentage.

Tagged Cell Rate (TCR) - An ABR service parameter, TCR limits the rate at which a source may send out-of-rate forward RM-cells. TCR is a constant fixed at 10 cells/second.

Telephony - The conversion of voices and other sounds into electrical signals which are then transmitted by telecommunications media.

Telnet - a TCP/IP protocol that defines a client/server mechanism for emulating directly-connected terminal connections.

Terminal Equipment (TE) - Terminal equipment represents the endpoint of ATM connection(s) and termination of the various protocols within the connection(s).

Throughput - Measurement of the total useful information processed or communicated by a computer during a specified time period, i.e. packets per second.

Time Division Multiplexing (TDM) - a method of traditional digital multiplexing in which a signal occupies a fixed, repetitive time slot within a higher-rate signal.

Token Ring - a network access method in which the stations circulate a token. Stations with data to send must have the token to transmit their data.

topology - a program that displays the topology of a FORE Systems ATM network. An updated topology can be periodically re-displayed by use of the interval command option.

Traffic - the calls being sent and received over a communications network. Also, the packets that are sent on a data network.

Traffic Management (TM) - The traffic control and congestion control procedures for ATM. ATM layer traffic control refers to the set of actions taken by the network to avoid congestion conditions. ATM layer congestion control refers to the set of actions taken by the network to minimize the intensity, spread and duration of congestion. The following functions form a framework for managing and controlling traffic and congestion in ATM networks and may be used in appropriate combinations:

Connection Admission Control
Feedback Control
Usage Parameter Control
Priority Control
Traffic Shaping
Network Resource Management
Frame Discard
ABR Flow Control

Traffic Parameter - A parameter for specifying a particular traffic aspect of a connection.

Trailer - the protocol control information located at the end of a PDU.

Transit Delay - the time difference between the instant at which the first bit of a PDU crosses one designated boundary, and the instant at which the last bit of the same PDU crosses a second designated boundary.

Transmission Control Protocol (TCP) - a specification for software that bundles and unbundles sent and received data into packets, manages the transmission of packets on a network, and checks for errors.

Transmission Control Protocol/Internet Protocol (TCP/IP) - a set of communications protocols that has evolved since the late 1970s, when it was first developed by the Department of Defense. Because programs supporting these protocols are available on so many different computer systems, they have become an excellent way to connect different types of computers over networks.

Transmission Convergence (TC) - generates and receives transmission frames and is responsible for all overhead associated with the transmission frame. The TC sublayer packages cells into the transmission frame.

Transmission Convergence Sublayer (TCS) - This is part of the ATM physical layer that defines how cells will be transmitted by the actual physical layer.

Transparent Asynchronous Transmitter/Receiver Interface (TAXI) - Encoding scheme used for FDDI LANs as well as for ATM; supports speed typical of 100 Mbps over multimode fiber.

Transport Layer - Layer Four of the OSI reference model that is responsible for maintaining reliable end-to-end communications across the network.

trap - a program interrupt mechanism that automatically updates the state of the network to remote network management hosts. The SNMP agent on the switch supports these SNMP traps.

Trivial File Transfer Protocol (TFTP) - Part of IP, a simplified version of FTP that allows files to be transferred from one computer to another over a network.

Twisted Pair - Insulated wire in which pairs are twisted together. Commonly used for telephone connections, and LANs because it is inexpensive.

Unassigned Cells - a generated cell identified by a standardized virtual path identifier (VPI) and virtual channel identifier (VCI) value, which does not carry information from an application using the ATM Layer service.

Unavailable Seconds (UAS) - a measurement of signal quality. Unavailable seconds start accruing when ten consecutive severely errored seconds occur.

UNI 3.0/3.1 - the User-to-Network Interface standard set forth by the ATM Forum that defines how private customer premise equipment interacts with private ATM switches.

Unicasting - The transmit operation of a single PDU by a source interface where the PDU reaches a single destination.

Universal Test & Operations Interface for ATM (UTOPIA) - Refers to an electrical interface between the TC and PMD sublayers of the PHY layer.

Unshielded Twisted Pair (UTP) - a cable that consists of two or more insulated conductors in which each pair of conductors are twisted around each other. There is no external protection and noise resistance comes solely from the twists.

Unspecified Bit Rate (UBR) - a type of traffic that is not considered time-critical (e.g., ARP messages, pure data), allocated whatever bandwidth is available at any given time. UBR traffic is given a “best effort” priority in an ATM network with no guarantee of successful transmission.

Uplink - Represents the connectivity from a border node to an upnode.

Usage Parameter Control (UPC) - mechanism that ensures that traffic on a given connection does not exceed the contracted bandwidth of the connection, responsible for policing or enforcement. UPC is sometimes confused with congestion management (see *congestion management*).

User Datagram Protocol (UDP) - the TCP/IP transaction protocol used for applications such as remote network management and name-service access; this lets users assign a name, such as “RVAX*2,S,” to a physical or numbered address.

User-to-Network Interface (UNI) - the physical and electrical demarcation point between the user and the public network service provider.

V.35 - ITU-T standard describing a synchronous, physical layer protocol used for communications between a network access device and a packet network. V.35 is most commonly used in the United States and Europe, and is recommended for speeds up to 48 Kbps.

Variable Bit Rate (VBR) - a type of traffic that, when sent over a network, is tolerant of delays and changes in the amount of bandwidth it is allocated (e.g., data applications).

Virtual Channel (or Circuit) (VC) - a communications path between two nodes identified by label rather than fixed physical path.

Virtual Channel Connection (VCC) - a unidirectional concatenation of VCLs that extends between the points where the ATM service users access the ATM Layer. The points at which the ATM cell payload is passed to, or received from, the users of the ATM Layer (i.e., a higher layer or ATMM-entity) for processing signify the endpoints of a VCC.

Virtual Channel Identifier (VCI) - the address or label of a VC; a value stored in a field in the ATM cell header that identifies an individual virtual channel to which the cell belongs. VCI values may be different for each data link hop of an ATM virtual connection.

Virtual Channel Link (VCL) - a means of unidirectional transport of ATM cells between the point where a VCI value is assigned and the point where that value is translated or removed.

Virtual Channel Switch - a network element that connects VCLs. It terminates VPCs and translates VCI values. The Virtual Channel Switch is directed by Control Plane functions and relays the cells of a VC.

Virtual Connection - an endpoint-to-endpoint connection in an ATM network. A virtual connection can be either a virtual path or a virtual channel.

Virtual Local Area Network (VLAN) - Work stations connected to an intelligent device which provides the capabilities to define LAN membership.

Virtual Network Software (VINES) - Banyan’s network operating system based on UNIX and its protocols.

Virtual Path (VP) - a unidirectional logical association or bundle of VCs.

Virtual Path Connection (VPC) - a concatenation of VPLs between virtual path terminators (VPTs). VPCs are unidirectional.

Virtual Path Identifier (VPI) - the address or label of a particular VP; a value stored in a field in the ATM cell header that identifies an individual virtual path to which the cell belongs. A virtual path may comprise multiple virtual channels.

Virtual Path Link (VPL) - a means of unidirectional transport of ATM cells between the point where a VPI value is assigned and the point where that value is translated or removed.

Virtual Path Switch - a network element that connects VPLs, it translates VPI (not VCI) values and is directed by Control Plane functions. The Virtual Path Switch relays the cells of a Virtual Path.

Virtual Path Terminator (VPT) - a system that unbundles the VCs of a VP for independent processing of each VC.

Virtual Private Data Network (VPDN) - a private data communications network built on public switching and transport facilities rather than dedicated leased facilities such as T1s.

Virtual Private Network (VPN) - a private voice communications network built on public switching and transport facilities rather than dedicated leased facilities such as T1s.

Virtual Source/Virtual Destination (VS/VD) - An ABR connection may be divided into two or more separately controlled ABR segments. Each ABR control segment, except the first, is sourced by a virtual source. A virtual source implements the behavior of an ABR source endpoint. Backwards RM-cells received by a virtual source are removed from the connection. Each ABR control segment, except the last, is terminated by a virtual destination. A virtual destination assumes the behavior of an ABR destination endpoint. Forward RM-cells received by a virtual destination are turned around and not forwarded to the next segment of the connection.

Virtual Tributary (VT) - a structure used to carry payloads such as DS1s that run at significantly lower rates than STS-1s.

Warm Start Trap - an SNMP trap which indicates that SNMP alarm messages or agents have been enabled.

Wide-Area Network (WAN) - a network that covers a large geographic area.

Wideband Channel - Communications channel with more capacity (19.2K bps) than the standard capacity of a voice grade line.

X.21 - ITU-T standard for serial communications over synchronous digital lines. The X.21 protocol is used primarily in Europe and Japan.

X.25 - a well-established data switching and transport method that relies on a significant amount of processing to ensure reliable transport over metallic media.

Yellow Alarm - An alarm signal sent back toward the source of a failed signal due to the presence of an AIS (may be used by APS equipment to initiate switching).

Zero Byte Time Slot Interchange (ZBTSI) - A technique used with the T carrier extended superframe format (ESF) in which an area in the ESF frame carries information about the location of all-zero bytes (eight consecutive “0”s) within the data stream.

Zero Code Suppression - The insertion of a “1” bit to prevent the transmission of eight or more consecutive “0” bits. Used primarily with T1 and related digital telephone company facilities, which require a minimum “1’s density” in order to keep the individual subchannels of a multiplexed, high speed facility active.

Zero-Bit Insertion - A technique used to achieve transparency in bit-oriented protocols. A zero is inserted into sequences of one bits that cause false flag direction.

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